

# **LAND AND PEOPLE OF THE HIMALAYA**

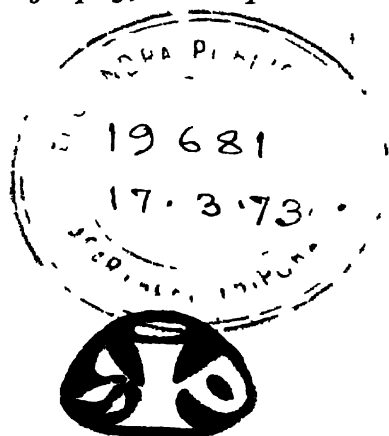


# LAND AND PEOPLE OF THE HIMALAYA

*By*

**Professor Subodh Chandra Bose, D. Phil.**

*Dept. of Geography, Gorakhpur University.*



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## Publisher's Note

The majestic Himalaya is the world's most formidable mountain barrier and it forms India's northern boundary. On a physical map the Himalaya appears as a gigantic crescent with the convex side bulging towards the North Indian plains. The snow fields of the Himalaya attracted the attention of ancient India's geographers who taking the help of India's traditional literature gave the name of the region as Himalaya ( *hima*, snow and *ālaya*, home ). The Himalayan landscape with its snow-clad peaks, vast ice-fields above the heads of large valley glaciers, deep river gorges and broad valley systems is well-represented in Kashmir and Himachal Pradesh as also in the northern regions of the Punjab, Uttar Pradesh, Bihar, West Bengal, Assam and its adjoining areas. Many picturesque spots occur in the Bapsa Valley and the Nandadevi group of mountains in Uttar Pradesh. A magnificent view of the snow-carved Kanchenjunga is obtained from Darjeeling in West Bengal. In the NEFA and Assam it is wilder and here the mountain system is rugged and inaccessible.

All the world's "eight thousander" peaks as also the world's youngest and longest east-west mountain system are situated in the Himalaya. The glaciers originate here at very high altitude from the mass of accumulated snow and glaciers are nature's gift to the people of India. They not only feed the great rivers like the Ganga, the Yamuna, and the Gandak, but also influence monsoon rainfall in the

plains and fresh snowfall in the mountains. The flowing water also does a great deal of constructive work. They build alluvial terraces in the Himalaya, piedmont plains at the foot of the hills, and mountains flood plains in their courses.

Professor Dr. Subodh Chandra Bose, the author of the book, is an expert on the land and the people of the Himalaya who has very ably treated all these in this monograph. Further he is taking a leading part in the Himalayan Section of the forthcoming International Geographers Union Meeting to be held in India in December, 1968. The author, it should be remembered here, has written as many as 23 research papers in different journals some of which were also read before the learned gatherings and congresses. The present book is more or less an outcome of these efforts but the differences obtaining between those papers and the present book is that it is edited in a style which makes it much more readable for a geographer or even for a layman. But this does not mean that the scientific merit of the book is smaller.

Born on September 14, 1905 at Rohtak (Haryana) Sri Subodh Chandra Bose, the author, received Government scholarship in 1921 from the Punjab University for Matriculation Examination ; again received Government scholarship in 1923 from Delhi University for I. A. He passed the M.A. in Geography from the University of Calcutta from where he obtained D.Phil. in 1954, for his original research on "Damodar Valley : a Geographical Analysis." Professor Bose, started his career as a teacher in 1925, joined 'The Statesman', Calcutta as a Cartographer in 1944, was a Research Officer in the National Atlas Organization for about 3 years and served as the Professor and Head of the Department of Geography in Karnatak University (Mysore) from where he joined the Gorakhpur University (U.P.) with the same capacity where he is now attached as a retired professor of UGC. He has also participated in a number of Himalayan expeditions and from

this practical experiences and book knowledge he had contributed papers mentioned above which are now collected in the present book form so that one is not obliged to seek them in different journals and sometime even less accessible publications. The whole work of a specialised scholar, as a whole, and in one place, to read it in continuo, is important. Otherwise, it often happens that one seeks a quotation in an older journal only to find there some necessary facts or so, but one does not read the whole work. A publication of the present type in one volume is, therefore, most welcome one.

These points may suffice to indicate the importance of the book of Professor Bose. There are practically all possible informations in the book where everybody will find desired interpretation, explications etc. and the geographers will find some useful discussions of several sections of geography such as physical and glacial features as well as the human geography etc. on the Himalayan problems. But it is not only this side of the book the importance of which we wish to stress ; after all one could find all these in the published papers in different Geographical journals or in the "Human Events", Calcutta where all these papers appeared serially from March to October, 1968. Much more important is what one gains by reading the book as a whole is the understanding of the geography and society of the Himalaya. The marshalling of facts and ability to combine geographical approach with others in a well balanced way has made the book useful and important because "without Himalaya perhaps India would not have been the India of today". Indeed, this aspect of the book gives it a very great value which should be read by wider circles. Keeping these in view the present book is planned by the Monograph Association of India and on their recommendation this has been included in the Monograph Series of the Indian Publications, Calcutta.

## Acknowledgements

I am very grateful to the editors and publishers of different Geographical Journals of India where most of the chapters of this book appeared first. I should also mention here that some of these chapters were also read before some learned organisations and before the students of different universities. My talks and lectures to my pupils in the classes conceived within the framework of this book, and to have put it into different works, would have been a vain labour.

I have profited a great deal from the advice of non-geographer friend, Sri Sankar Sen Gupta of the Monograph Association of India, who gave just the criticism or logical points throughout, which an author can best turn to advantage. I should like to take this opportunity of thanking him for editorial work when the chapters appeared serially in "Human Events" and thereafter.

My wife Smt. Sucharita Bose accompanied me on many of the Himalayan trips and helped me a lot. My mountaineer son Sri Sujit Bose gave me some useful information of the higher altitude that are recorded here. I am also thankful to Sri Bireswar Banerjee, D. Litt. for introducing me to the Publishers.

I also thank Sri B. Majumdar of the Printers' Corner Private Ltd, for all possible assistance in printing and Sri C. R. Sen Gupta of the Indian Publications for publishing it quickly and Sri Chandi Lahiri for cover design.

S. C. B.

## Preface

**Himalaya is the mightiest mountain of the world. It is also the least known. The complex geological study of the Himalaya is still to be fully understood. The mountain has largely remained inaccessible and remote. It is the habitat of colourful hill people whose culture and appearance differ from place to place.**

Some knowledge has been gained from travellers' accounts and studies by mountaineers who come from all over the world to scale its mighty peaks. Strategic reasons have forced the defence department to know more about this obscure region. The interest of people has also been roused, who are going in larger numbers for holidaying in the Himalayan ranges.

I myself have travelled widely in the Himalaya and studied its physiography and its people, so far as I could, in a lone effort. The result is this book. I hope, much that is written here about the Himalaya will be found useful for those who want to know more about this mountain as well as those who are the lovers of the Himalaya.

The book has rather been printed in haste to present it before the world geographers on the occasion of their visit to India in connection with the International Geographers Union Meetings in December, 1968. The mistakes which inevitably crept in the book will be removed as early as possible in its next print. I shall invite the readers of the book to give their opinion and suggestion for future revision.

The book is mainly a collection of my papers published in various learned journals. Thus it may contain some repetitions for which I alone am responsible. The book, as will be seen, has been divided into two parts. The first part contains some general chapters describing the lay of the land. The second part gives some micro-regional studies, specially dealing with the people and their ecesis.

I have tried to illustrate the book with maps and photographs so far as it is possible in a short time.

I am thankful to all persons who have been of help to me in my travels, and in the publication of this book. I am also thankful to editors of learned journals, where my papers have been published. The names of most of these journals have been mentioned at the notes and references. The entire text of this book, it should be mentioned, appeared first in "Human Events", Monthly Organ of the Monograph Association of India for which I offer my grateful thanks to its editor, Sri Sankar Sen Gupta. My sincere thanks are due to him for his editorial work on the chapters of the book. I have also mentioned this and everybody's help and assistance that I have received for this book, in the acknowledgements.

S. C. Bose

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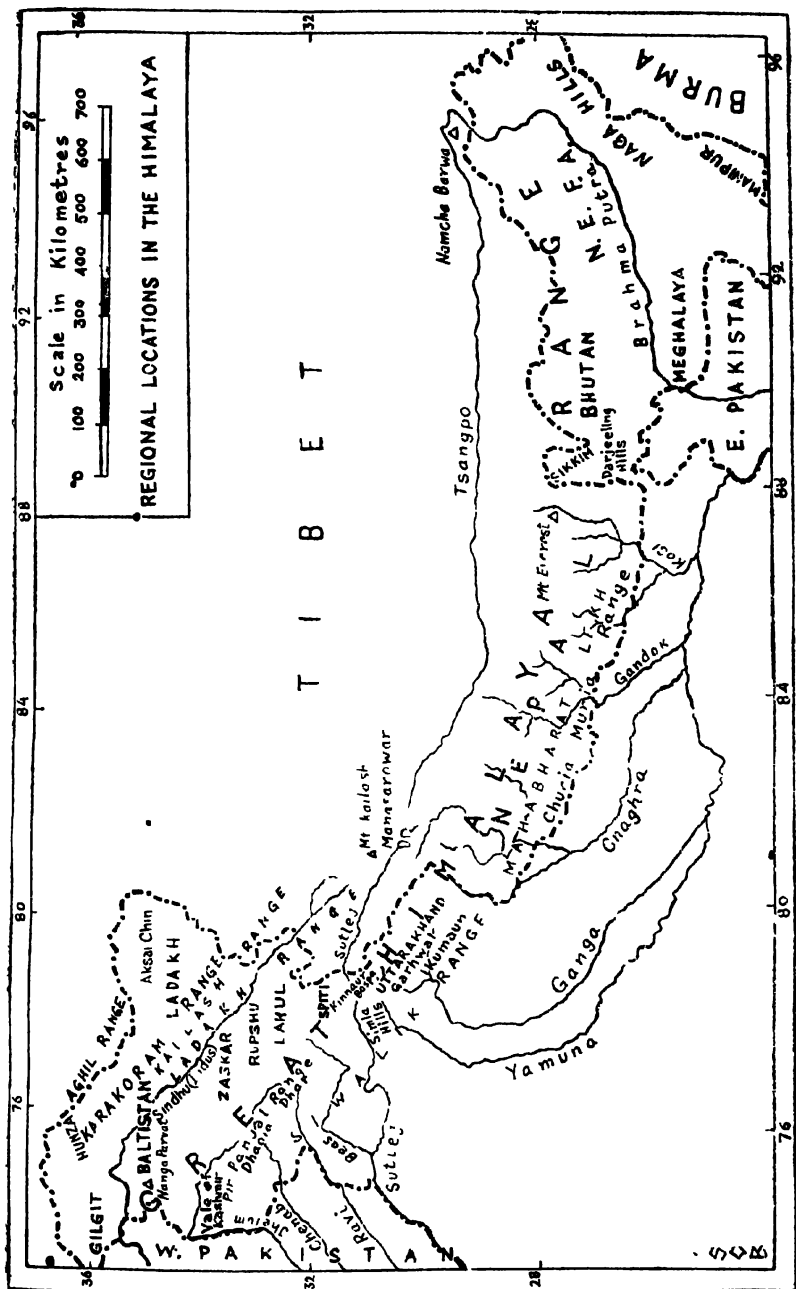
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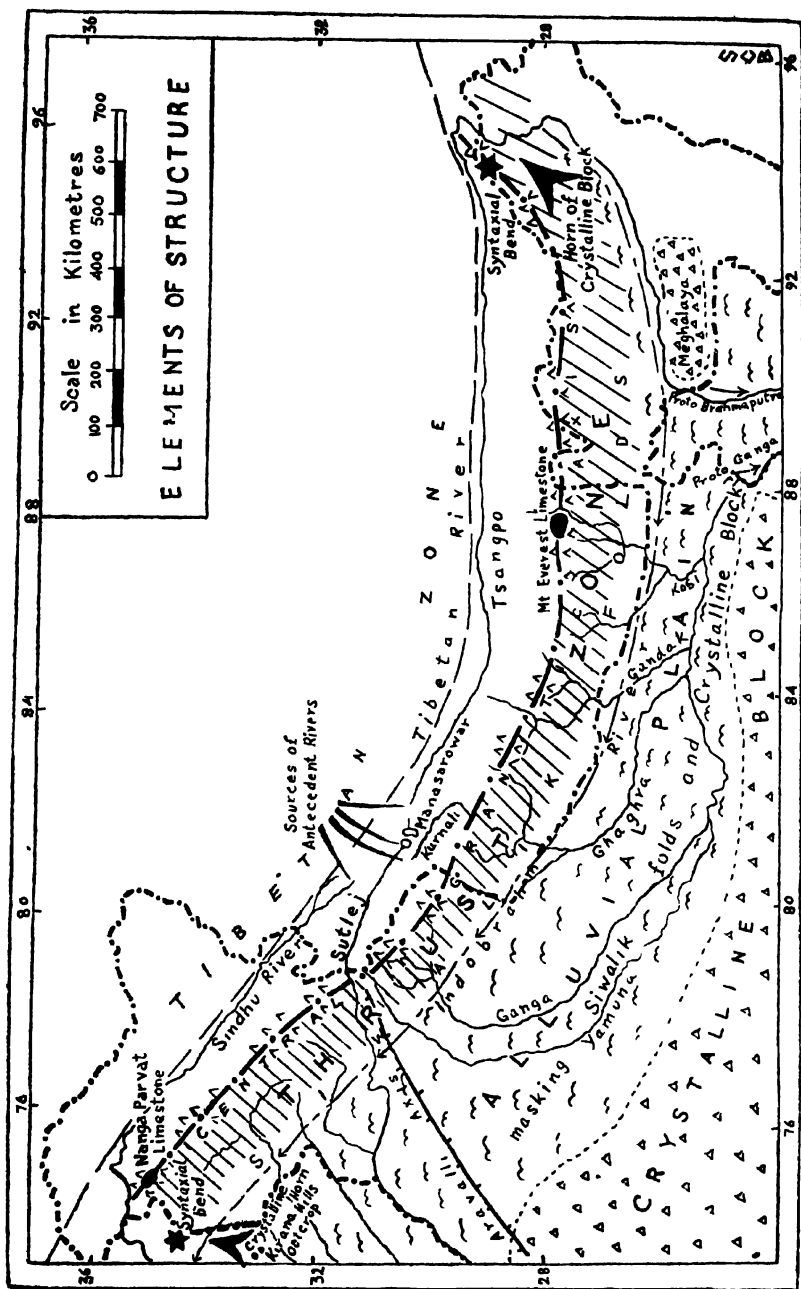


**I**  
**THE LAY OF THE LAND**





Map 1



Map 2

# 1

## Location, Extent and Relation

The great fold ranges which spread from east to west through the middle of the old world constitute the greatest system of mountain ranges. In between these ranges are high plateaus like Tibet, Irano-Afghanistan and Anatolia. The ranges group into knots at Pamir and Armenia. They attain the maximum height between Nanga Parvat and Namcha Barwa, two peaks, both over 8,000 metres high. This is the central part of the Himalaya, spreading as a great arc, bulging southwards.

Kalidasa described Himalaya in his immortal verses in 'Kumarasambhavam', and he perhaps visualizes first the whole of the east-west range, spreading from the Pacific to the Atlantic as the Himalaya. His idea is beautifully explained by Swami Vivekananda to his disciple, K. S. Ramaswami Shastri, in a writing in 'Prabuddha Bharat.'

'One morning I was reading Kalidasa's 'Kumarsambhavam,' Swamiji came in. He asked, 'What is that book you are studying?' I replied, 'It is 'Kumarsambhavam,' Canto I.' He asked, 'Can you repeat the great poet's description of the Himalaya?' I repeated in the usual musical mode current in South India, the beautiful and sonorous verses which constitute Kalidasa's description of the Himalaya. Swamiji smiled and looked pleased. He said, 'Do you know that I am coming after a long stay amidst the sublimity of the Himalayan scenes.' I felt elated. He asked me to repeat again the opening stanza. I did so. He asked, 'Do you know its meaning. Tell me.' I did so. He said, 'That is good but not enough.'

He said, 'important words in this verse are *Devatatma* (ensouled by Divinity) and *Manadanda* (measuring rod). The poet implies and suggests that the Himalaya is not a mere wall accidentally constructed by nature. It is ensouled by Divinity and is the protector of India, and her civilization, not only from the chill icy blasts blowing from the Arctic region, but also from the deadly and destructive incursions of invaders. The Himalaya further protects India by sending the great rivers like Sindhu, Ganga and Brahmaputra perennially fed by melting ice, and irrespective of the monsoon rains. Manadanda implies that the poet affirms that the Indian civilization is the best of all human civilizations and forms the standard by which all other human civilization, past, present and future must be tested. Such was the poet's lofty conception of patriotism.' I felt thrilled by his words. I treasure them even to this day and they shine in my heart even now with an undimmed and undiminished splendour.'<sup>1</sup>

"Himalaya that holds a spell over the poets, the painters, the sages and the saints alike, has cradled everything precious to India's heritage. The nursery of peace and religion, Himalaya offers a landscape almost painted to perfection with careless strokes of the Master

**Painter.** Living on the slopes and the valleys of Himalaya are the sturdy people in whose lives a wind of change is gradually blowing in. In this change what is precious must be cherished, what is essential must be got."<sup>2</sup>

Himalaya has been supposed to be the abode of gods and goddesses from time immemorial. Here are situated hundreds of shrines sacred to the Hindus and other religions. Among famous Himalayan shrines of the Hindus are—Badrinath Kedarnath, Tunganath, Joshimath, Ukhimath, Gupta Kashi, Triyugi Narayan, Uttarkashi, Gangotri, Yamunotri, Manikaran, Amarnath, the sacred cave in Kashmir, Naina Devi, a spring, Pashupatinath in Kathmandu, Muktinath in Upper Krishna Gandaki Valley and so forth. There are numerous Buddhist monasteries all over the Himalaya, specially in the high Himalaya. Some of these monasteries are famous, such as, Tawang in North East Frontier Agency, Swayambhunath in Kathmandu, Thyangboche near Everest, Hemis in Ladakh and so forth. A strange religious centre is Rawalsar lake near Mandi, where floating islands move by prayer, and where there are shrines of Hindus, Buddhists and Sikhs. River junctions are supposed to be sacred places, such as, Dev Prayag where the Bhagirathi meets the Alakananda, Rudra Prayag, Karna Prayag, Vishnu Prayag and so forth.<sup>3</sup>

Himalaya has acted as a nearly impenetrable barrier to the north of India, saving her from unfriendly intrusion from that direction. It also acted as an obstruction for the spread of Indian culture northwards. Trade through high Himalayan passes in both directions has, however, continued, may be in small amounts, of specialized goods. Today this physical barrier is very slowly yielding to modern road building and many motorable or jeepable roads have been built across the passes, such as, the Indian and Chinese made roads to and through Ladakh connecting near Chushul, the Tribhuvan Rajpath to Kathmandu, extending northwards to Kodari and Lhasa, the jeep road to Nathu La and beyond into Chumbi valley and a few

other roads. The conquest of the air and specially the advent of powerful helicopters has further made movement easy in the deep inaccessible regions of Himalaya. Perhaps military movement through the Himalaya has also become easier.

With an average height of six to seven thousand metres Himalaya cuts through a major portion of the air envelop of the earth. It thus fairly effectively separates the Indian air mass from the Asian air mass. Meteorological phenomena in India, specially the wet monsoon, are much influenced by this factor. Himalaya thus helps in producing the monsoon for India. It further helps in keeping its precipitation, both water and snow for us, as very little moisture can escape across this gigantic barrier.

The snow-fields and glaciers of the Himalaya act as a great water reservoir, specially giving much snowmelt water in May and June, when rain water supply is scanty. Due to latent heat of water, the snowmelt water supply is well regulated.

The great Himalayan ranges are being constantly eroded by running water and frost. The eroded material is being slowly removed to the plains of northern India in the form of fertile alluvial soil in general. In fact the plains of Punjab, Uttar Pradesh, Bihar, West Bengal and Assam are largely made up of eroded material obtained from the Himalaya.

Himalaya has given us land, covered it up with a fertile veneer of soil and poured water on to it.

There is much potential hydro-electric power in the falling waters of Himalayan rivers. It is being slowly harnessed, such as at Bhakra on the river Sutlej. River Tons, a tributary of Yamuna, Ram Ganga, a tributary of Ganga, Sharda a tributary of Ghagra, Gandak near Bhainse Lötan, Kosi and many other Himalayan rivers are being harnessed. These river projects are often multi-purpose schemes, and water reservoirs built for them provide water for the production of electricity by falling



through the penstocks and later irrigate the fields, being not consumed. This huge potential of power has yet to be fully tapped.

There is much natural wealth in Himalaya in its forest giving timber, resin, wood pulp and so forth. There is sure to be much unexploited mineral wealth. Mountain agriculture and specially horticulture is further increasing the economic resources of the Himalaya.

For the residents of the hot plains Himalaya has provided many health resorts. People flock to the cool hill stations like Darjeeling, Nainital, Simla and Dalhousie during the summer months. Tourists visit these places as well as the vale of Kashmir and other spots such as Kulu, Khajiar, the valley of flowers ( Lokpal ), Gohna lake and places like Pahlgam, Sheshnag and Sonamarg. More adventurous people trek to higher regions like Pindari glacier, Basu Dhara, Gaumukh and so forth. Mountain climbers come from all over the world to scale defiant Himalayan peaks. This sport is spreading among Indians. Himalaya gives ample opportunity to casual visitors, tourists, trekkers and sportsmen to enjoy life.

Lastly millions of pilgrims visit the Himalayan shrines like Kedarnath, Badrinath and Amarnath every year, and so this mountain caters to the religious sentiments of the masses.

Without Himalaya perhaps India would not have been the India of today.

#### NOTES

- 1 Prabudha Bharat, Sept.-Oct.—1953
  - 2 Social Welfare, Feb. 1968.
  - 3 Social Work in the Himalaya Seminar in Delhi, December 1967
- Village Location in the Himalaya by S. C. Bose.

## Geology and Structure

A cursory glance at the orographic map of India, reveals its three major physiographic regions, which are also its three geological regions. These three distinct segments of India are :—

(i) *The Deccan Peninsula* : A solid and stable block mainly composed of the primitive crust of the earth, which is in all probability a remnant of a larger block, parts of which have drifted away and parts perhaps founded in the ocean bottom. It is largely composed of some of the most ancient rocks of the globe, covered here and there by the very first sedimentary rocks, which originated in primeval hollows filled by condensation of water vapour from the still hot atmosphere. These have been carved by millions of years of denudation into scarplands, plateaus and well graded valleys, the sharper features, such as, steep mountain sides and waterfalls being largely produced by block faulting.

(ii) *The Northern Mountain Wall* : It consists of intensively folded young ranges, made up of thousands of metres of sedimentary rocks laid in a gigantic trough or geosyncline. The mountain folds were thrown up by a major crustal shortening, occurring along a broad girdle of the globe, which resulted in the creation of high Tertiary folded ranges all over the world, the Himalaya being the highest and the broadest. Here the push came from the north and folds were thrown forward in complex recumbent folds and over-thrusts. Unlike the Deccan stable block, which was dry land for the major part of its history, the northern mountain wall was underneath the sea practically throughout its formative period. It preserves

within its massive folds marine deposits of all the geological periods after the Vedic ( Archaean ) Era, i.e., from Algonkian and the Cambrian at the beginning of the Palaeozoic to the Pleistocene and recent deposits. In Spiti and Narikhorsam in Sutlej valley, there occur continuous, uninterrupted exposures of all these beds, a veritable museum for geologists.

(iii) *The Sindhu-Ganga Plain* : It was originally a deep furrow, which came into existence as a compliment of the process of elevation of the Himalayan ranges to the north. The furrow was largely filled up by gravel, sand and silt brought down by rivers flowing southwards from the rising Himalaya in Pleistocene age. Underneath the deep mantle of alluvium lie buried valuable geological records which might have proved very useful in throwing light on the accurate forms of the mountain ranges and their sudden bends in Sibi, Salt Ranges and Patkai, due to the hidden horns of the old block. The plains covered by old and new alluvial soils are fertile and densely populated, but geologically they are not of much importance.<sup>1</sup>

Rock formations found in the Himalaya representing the various geological ages beginning from the oldest Archaean rocks, their geographical significance in the creation of landforms and the occurrence of minerals in them, is described in what follows :

### Archaean System

This is the first solidified crust of earth, as it cooled from its original molten condition. It forms the basement of all succeeding rock formation. As such, it constitutes the Deccan Peninsula stable block, with superficial blanketing by ancient sediments here and there, and a rather large portion in the north-west by outpourings of lavas during the Cretaceous age, when the Himalaya was on the verge of emerging from the sea. The crystalline complex of Archaean igneous rocks consists mainly of a mixture of granites, gneisses and schists, which are

intruded by injections of magma from deeper parts of the crust. The crystalline complex is further associated with sediments, which have undergone an extreme degree of metamorphism due to heat and pressure, so much so, that they could not be recognized as sedimentary rocks for a long time.

The fundamental gneisses consist of the great mass of crystalline igneous rock-complex forming the Archaean gneisses of the Deccan block. They consist of gneisses, granites, charnokites, anorthosites, granulites, marbles, manganese bearing kodurites and so forth. They have been grouped into several regional units, not based on any chronological order. These are Bengal gneiss occurring in north-east India mainly, Bundhelkhard gneiss of Central India, Khondolites, Charnokites and the Central gneiss of the core of the Himalayas.

The Central gneisses form the core of the main Himalayan range stretching from Nanga Parbat to Namcha Barwa and also in Ladakh, Zaskar and Dhauladhar. They are, however, much mixed up with younger intrusive granites and highly altered Archaean sedimentaries.

### Dharwar System

The Dharwarian rocks are perhaps the oldest sedimentary rocks in the world. They were deposited in the hollows and depressions of the primeval crust of earth, when it congealed from its earlier molten state, in the first water bodies formed in them by the condensation of water vapour of the primeval atmosphere. Since then they were involved in various earth movements, and were much transformed and metamorphosed by heat and pressure, so much so, that it is difficult to recognize their sedimentary origin. They are completely devoid of fossils, as there was no life on earth.<sup>2</sup>

The Dharwarians consist mainly of slates, schists, quartzites, phyllites, clastic-granulites and crystalline limestones charged with frequent granite intrusions.

The Dharwarian rocks occur in patches in the Middle Himalayas. Crystalline rocks, granites, gneisses and schists occupy large areas in Kashmir, Simla, Sikkim and Darjeeling. Forming, generally the core of the central Himalaya, and of parallel ranges of Ladakh, Baltistan, Zaskar and Dhauladhar, they have been called "Central gneisses". But much of this gneiss is of intrusive origin, and therefore much younger. It is found intrusive in Permians of Pir Panjal, Jurassics of Chitral, Cretaceous of Burzil valley in Kashmir, and even in Eocene of Eastern Tibet. Most of the high peaks of the Central Himalaya are not made of granite, as previously supposed, but of altered and metamorphosed sedimentaries, such as, quartzites and crystalline limestones. Nanga Parbat is of a similar nature. Mount-Everest is also made up of limestones, which are perhaps of a younger age, containing fossils.

The central crystalline complex of the Himalaya, therefore, consists mainly of three types of rocks: (a) the ancient crystalline crust of earth, i.e., the fundamental gneisses, (b) the Archaean sedimentaries, much altered specially from intrusions, which were numerous and occurred intermittently up to Eocene. They are unfossiliferous and akin to Dharwarian sediments of the Peninsula, (c) younger intrusive igneous rocks.

Some of such rocks show remarkable similarity of Dharwarians of the Peninsula, which proves that they formed the basement on which the sediments of Tethys sea were laid down in the Himalayan geosyncline. They thus formed the cores of the central anticlines, and have now been exposed by erosion.

In Spiti they are called *Vaikrita series* and near Simla they are called *Jutogh series* consisting of slates, limestones, dolomites, quartzites and schists. Here the Chor peak is formed of intruded granite. A similar formation called *Daling series* occurs in Darjeeling and Sikkim, containing phyllites and schists which give rise to frequent landslides. Copper ores are found in them in Sikkim.

### Cuddapah System

A profound regional unconformity is observed at the end of Vedic (Archaean) era, which denotes a vast interval of time in which there were many movements of mountain building, and their erosion to base level. The lowest beds which were laid upon this ancient surface in the beginning of Purana era (Algonkian, the lowest in Palaeozoic) are called the Cuddapah System.

The type area for Cuddapah rocks is a crescent shaped region of hills and valleys in Cuddapah district of Andhra Pradesh, spreading between rivers Krishna and Pennar. Here nearly 7,000 metres of slates, limestones and quartzites are found. Slates and stone slabs are quarried from this region and exported to all parts of India. The limestone has given rise to a cement factory near Panyam. The Cuddapahs are totally devoid of fossils.

In all probability the Cuddapahs were also laid over the Dharwarians in the Himalayan geosyncline, and were subsequently raised up during the buckling up of the Himalaya. Metamorphosed sediments lying to the south of the central crystalline axis of the Himalaya are supposed to correspond with the Cuddapahs of the peninsula.

### Vindhyan System

This system consists of a vast sedimentary formation of shales, limestones and sandstones, being about 5,000 metres thick, which are preserved today almost in their original horizontal disposition, and which show practically no trace of metamorphism, in spite of their great age, unlike the older Dharwar and Cuddapah systems. They also show some signs of life appearing in the world. They show structural disturbance only near the contact with older Aravalli rock, where the junction is a boundary fault. The Vindhyan were, therefore, raised from the sea bed, in which they were deposited, by an epeirogenic uplift. The peninsula, since then, has largely remained an impassive solid block, unsusceptible to any folding movements.

Similar to Dharwarians and Cuddapahs, rocks related to Vindhya also occur in the Himalaya in isolated patches in a belt between the metamorphosed rocks of the central axis and the younger sedimentaries further down to the south. They are the *Dogra Slates* overlain by unfossiliferous *Tanawal series* in Pir Panjal and Dhauladhar ranges, *Simla Slates* and Jaunser series in Simla hills and Buxa series of quartzites, slates and dolomites near Darjeeling. These older rocks overlie younger rocks along a plane of over-thrust, which is a common feature throughout the length of the Himalaya.

### Changes in Vedic-Purana Eras

Summarizing major geographical and geological events during the Vedic and Purana eras, the Indian subcontinent consisted of a congealing primeval crust, which was perhaps part of a single block of continental mass of sial, called Pangaea by Wagener. Up to the end of Purana era various systems of sedimentary rocks were laid upon this block of fundamental gneisses. The first system of such rocks were Dharwarians, which were deposited in hollows throughout the Indian subcontinent including the area now occupied by the Himalaya up to its central axis.

After the laying of the Dharwarians there were many mountain building movements in which the Dharwarians were involved. They were folded, faulted, compressed and injected by magma from beneath and the Dharwarian sediments were completely metamorphosed. But at the end of Vedic era, the subcontinent remained dry for a very long period and was subject to erosion. It was only during the Purana era, that the sea invaded many parts of India in which the Cuddapah system of rocks were deposited, spreading again upto the central Himalaya axis. This was again followed by tangential earth crustal movements, like their predecessors the Dharwarians. A major mountain building movement created a huge

mountain across the peninsula, the Aravalli. A prolonged dry period now ensued denuding the peninsula and eroding the Aravalli.

The peninsula was drowned once again and the Vindhyan beds were laid over the eroded plateau surface. An epeirogenic uplift then occurred and raised the Vindhyan strata, little disturbing their horizontal attitude. The Aravalli had its last rise at this time. The Vindhyan then appeared as gigantic plateaus and scarps, while the Aravalli stood high as the most dominating feature of India.

All along this time the Himalaya did not exist, and the Dharwarian, Cuddapah and Vindhyan sediments were laid one above the other on the fundamental gneisses in a belt where the axis of the Himalaya now lies, and its south. They were subjected to the same stresses, strains, intrusions and metamorphism as their counterparts in the plateau.

After the Purana era there was another long land period.

### Dravidian Era

This dry period is called the Dravidian Era, which succeeded the deposition of Vindhyan rocks. The whole of the plateau remained completely dry in this era. The Salt Range, Western Kashmir and Hazara were also dry at this time. This served as a land bridge between Gondwana land and Angara land.

But the Tibetan zone of Himalaya which lies north of its central axis was submerged during this era. We find here, in a broad belt, extending from northern Kashmir to Spiti, Garhwal, Kumaon and Nepal a complete sequence of Palaeozoic rocks, which is absent in the rest of India. In fact, the Tibetan zone of Himalaya shows a long, uninterrupted sequence of sedimentary deposits from Cambrian to Eocene, which is the most perfect and legible exposition of stratified rocks of the earth.



### Gondwana System

The end of Dravidian or Palaeozoic forms a land-mark in the geological history of India. The subsequent period in Indian terminology is called the Aryan era. The beginning of this era saw the setting up of an ice age over the subcontinent. The great Aravalli range was covered by an ice cap from which emanated large glaciers in all directions. Today we find glacial boulder beds (Talchirs) and conglomerates in many parts of India deposited at this (Upper Carboniferous), standing witness to the past ice age. They form the base of many sedimentary deposits, which started after the Dravidian dry period.

The area covering the Himalaya henceforth was invaded by a widening and deepening Tethys sea, designated as the Himalayan geosyncline. In it were deposited vast piles of sediments.

In the Peninsula the stresses and strains of the deepening of the geosyncline at its northern edge, manifested themselves in the formation of cracks and fissures, and subsidence of large tracts, where water-filled basins and lakes were formed. Henceforth, therefore, while we find marine deposits in the Himalaya, we get riverine and terrestrial deposits in the plateau region, called the Gondwana system.

This system of land deposits was laid in the beginning of the Aryan era (Permo-Carboniferous) in the Damodar, Mahanadi and Godavari valleys and the Satpura, where they occupy areas where basins and depressions were formed in the plateau. Some patches also formed at the northern edges of the plateau in the Salt Range, Kashmir, Darjeeling and small patches in Assam.

Central India at this time was covered by dense forests, and the Gondwana deposits have rich coal seams, some times nearly 30 metres thick (the Kargali seams in Bokaro coal field).

The lower Gondwana deposits began with a glacial

boulder bed at the bottom, testifying to the prevalence of an ice-age. This is overlain by the *Damuda series*, which contain coal seams. In this series are also included iron-stone shales, which contain some iron only at the surface, and have proved a failure as suppliers of iron ore for modern iron and steel industrial plants, though they have been used locally in small village furnaces. The coal seams have been specially preserved in fault-bounded rift valleys and basins, as in the upper and middle Damodar valley. They are overlain by sandstones and shales of *Panchet Series*. Sandstones and conglomerates stand out as hillocks, as the Panchet hill near Assansol. A feature of the Gondwana sediments is the presence of *Gangamopteris* and *Glossopteris* flora preserved in them. The presence of this flora in Africa, Brazil and Australia constitute a strong proof of the close proximity of the continents in the distant past, which broke asunder and drifted away later.

Great climatic changes occurred at this time in India and the Arctic cold gave way to dry semi-desert climate. The dense forest disappeared. The Upper Gondwanas were deposited at this time (Upper Triassic to lower Cretaceous) as massive sandstones and conglomerates. These are most prominent in the 3000 metre thick sandstone beds in Mahadeo hills around Pachmarhi, where they are carved into gigantic plateaus and scarps. They also occur in the Godavari valley and in Kachh. In Rajmahal they are associated with lava beds.

#### Marine deposits

During the Gondwana Era Upper Carboniferous to Cretaceous deposits continued to pile up in the Himalayan Geosyncline which kept on sinking. Sediments of Carboniferous and Permian age are well displayed in the Salt Range. They begin with boulder beds containing glaciated pebbles of crystalline rocks brought from the south. Over them are laid sandstones and shales containing *Gangamopteris* and *Glossopteris* flora, proving that

these beds are contemporary to the Gondwanas of the peninsula. These beds are followed by marine limestones, called productus limestones.

Similar deposits are found in Spiti, consisting of conglomerates overlain by Calcareous sandstones and Productus shales. The physical geography of Kashmir underwent a violent change and vulcanicity engulfed the area, being most intense in the permian. It covered large areas of Kashmir with 2,500 metres thick lavas and tuffs. The lower of these rocks are called agglomeratic slates, while the upper ones are termed Panjal traps. They build the majority of high peaks around Jhelum valley including Kolahoi.

The Kashmir area reverted back for a brief period to Gondwana land, becoming its northern boundary. Beds containing *Glossopteris* and *Gangopteris* flora lying over the Panjal trap, occurring in several places, such as, at Golabgarh, prove this. But soon the sea invaded the region and marine shales and limestones of *Zewan series* were laid upon them. In Vihi valley, near Pampur in the Vale of Kashmir, the relation between Panjal volcanics, Gondwanas, Zewan and successive Triassics are very well displayed.

In Simla the Simla slates akin to the Vindhya are overlain by *Krol series*, beginning at the bottom with boulder beds covered by pink coloured dolomitic limestones.<sup>3</sup>

After permian in the succeeding Mesozoic age, marine deposits were laid extensively in the Himalayan region. *Triassic* blue limestones, slates and dolomites are displayed in hills bordering Kashmir valley. The volcanic springs of the valley occur in them. At Lilang in Spiti Triassic sedimentaries and their relation to contemporaneous rocks of Europe is closely brought out.

- The Jurassic strata, succeeding Triassics lie conformably all over the Himalayan region in a great thickness of limestones and shales. They occur in Baluchistan,

Salt Range, Zaskar, Spiti, Garhwal and Kumaon. They occur again in Mt. Everest region, which is formed of Jurassic limestones.

Jurassic sandstones and black shales are again met with in Garhwal as *Tal series*. Their occurrence south of the central axis of the Himalaya indicates a slight extension of the Tethys beyond its southern border.

Like Jurassic the *Cretaceous rocks* are very well developed in Spiti. The Jurassic Spiti shales are overlain by sandstones, white limestones and shales of Cretaceous age. A large area from Ladakh to Shigatse is also covered by Cretaceous limestones. In Kashmir the Cretaceous are not well developed like the Jurassics.

In Malla Johar in Kumaon near the Tibetan frontier, a number of detached blocks of various ages from Permian to Jurassic are found scattered haphazardly over Cretaceous rocks. Fossils in them are more like those found in Alps. The existence of these "Exotic" blocks can be explained with difficulty, perhaps a violent volcanic explosion, bringing them here from great distance, or the nappes whose main bodies have been denuded.

#### Vulcanicity in Lower Cretaceous

Towards the close of the Cretaceous there was a stupendous outburst of volcanic energy in the peninsula. At the same time volcanic and plutonic activity manifested itself in the Himalaya. An immense quantity of magma was intruded in the rocks which had been laid earlier, and portions of it ejected on the surface over wide areas in Baluchistan, North-West Himalaya, Kumaon and Burma. The chromite ores of Baluchistan and Jades of Burma resulted from this volcanic activity. Masses of granite, gabbros and periodotites penetrated the older rocks in bosses, veins, laccolites and sills. Lavas and ash beds spread on the surface. A great portion of the granite in the crystalline core of the Himalaya is of Cretaceous age.

This outburst of igneous forces is connected with tremendous convulsions which preceded the rise of the Himalaya from the ocean bottom, the obliteration of the Tethys sea, the breaking asunder of the old Gondwana continent, the drifting away of Africa and Australia, and the massive outpouring of lavas over a large part of the Deccan plateau.

*The Deccan Trap* : In the Deccan plateau the great igneous outburst at the end of the Cretaceous produced large fissures and cracks through which great masses of hot liquid poured out intermittently, which congealed into perfectly flat beds, at some places more than 3,000 metres thick. They obliterated the previous scenery and changed it to a number of step like lava plateaus, named "Trap". They covered nearly one-third of the Deccan plateau to its north-west.

*Tertiary Era* : This is the later part of the Aryan Era. It was initiated at the end of the Deccan trap and the break up and drifting apart of Africa and Australia. The great geodynamic energy shown by the gradual rise of the Himalaya from the bottom of the Tethys was reducing in size as the Himalaya rose in the Eocene. The rivers of Deccan plateau drained northwards into it north of the Vindhya-Kaimur Rajmahal divide. South of it the rivers flowed into the Indian Ocean. There were two gulfs, the Sind gulf stretching up to Simla and Nepal and the Assam-Burma gulf. The Ganga plain was an eroded rocky surface.

Thick sedimentary deposits slowly filled the two gulfs, mentioned above, which gradually became broad estuaries of the Sindhu and the Ganga-Brahmaputra. So the lower Tertiary beds are marine, while the later are estuarine and riverine. The lower Sub-Himalayan range almost entirely consists of these rocks, the Eocene and Oligocene being marine and the Miocene and Pliocene of fresh water. All the Tertiaries are well displayed in the Salt Range, and Assam. Among the Eocene rocks occur

rock salt, coal and mineral oil. Rock salt occurs near Mandi in the Beas valley in Himachal Pradesh. But its main occurrence is in the Salt Range in West-Pakistan. Tertiary coal occurs in scattered localities in the foothills, such as, at Riasi and Assam. Mineral oil occurs in Oligocene rocks in Assam, Attock ( West-Pakistan ) and Burma.

Central Tertiaries in Gujarat have also yielded oil. They have valuable deposits of lignite at Nyeveli in Madras. Tertiary beds are found in many coastal areas, such as, Kathiwar, Surat and Broach in Gujarat, Kachh, Rajasthan (fairly inland up to Bikaner and Jodhpur ), Malabar and Coromandel coast.

*The Siwalik System* constitutes the Upper Tertiary rocks, consisting of sand-rocks, clays, and conglomerates, more than 5,000 metres thick and spreading inland from Punjab to Assam. They form low ranges of hills south of, and parallel to the Himalaya. The Siwalik beds have preserved a wealth of skeletal remains of large mammals, such as, elephants, rhinoceroses, horses, deer and pigs, including anthropoid apes, the immediate ancestors of men. With the end of the deposition of Siwaliks, the last phase of Himalayan upheaval gradually came to an end.

### Structure of the Himalaya

The Himalayan uplift occurred in three phases. The first was the post-Eocene Uplift, which drove back the last remnants of the Tethys sea in the Himalayan area, and upheaved the ocean floor to rise in folded ranges. The nummulitic limestones deposited in this sea were raised at places from 5,000 to 7,000 metres.

The second major uplift came in *Post-Miocene* which raised the sediments of lesser Himalayan Zone, and also folded them into huge recumbent folds, and thrust them southwards over younger rocks.

The third and the last uplift occurred in the Pleistocene, after the Siwalik beds had been laid, for these were lifted,

folded and thrown forward, at places over later Pleistocene alluvium.

*Recumbent Structure* : A well recognised feature of the structure of the Himalaya is the existence of gigantic recumbent folds, which have fallen southwards so that the older rock systems of the central axis have fallen over the younger rocks of the outer zone. They have been further sheared and thrust southwards over considerable distances. The main cause of such recumbent folds and overthrusts is an extreme degree of crustal shortening and a great push from the north. At least two such regional thrust can be clearly recognised. In one of these the younger Tertiary rocks of the outermost Zone are over-ridden by the Permo-Carboniferous series, such as, Panjal volcanics, Blaini or Krol. In the others the later are over-ridden by immense recumbent folds of metamorphic Purana or even older sediments of the inner Zone. The roots of the second recumbent folds, ( or nappes ) lie much to the north of the central axis.

*Syntaxial Bends* : A noteworthy feature of the Himalayan structure is the syntaxial bends in the north-west and the north-east, also referred to earlier. The great bend in the Jhelum valley in Kashmir around Domel pivot is specially remarkable. Here the Murree and Siwalik systems are wrapped round this pivot. A minor bend is witnessed at Sibi in Baluchistan.

The obvious reason for these bends in Kashmir and Assam are the hidden horns of the Gondwana foreland, consisting of a massive stable igneous mass, compared to which the Himalayan sedimentaries are thin and soft.

In Punjab (Pakistan), the Kirana hills near Sargodha, made up of inliers of Peninsular rocks, are a clear proof of the existence of the north-western horn. In the north-east the Shillong plateau is in all probability connected with the Peninsular block at Rajmahal and continues north-eastwards under the Brahmaputra alluvium to the pivot below Namcha-Barwa peak.

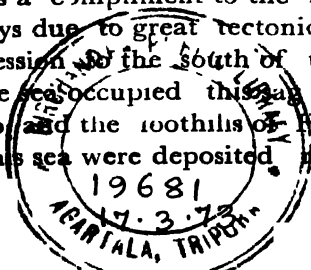
The relative movement between the Himalayan folds and the Peninsular horns is not certain, but it could be both ways. In any case the final result is shown by the syntaxial bends.

### Quaternary glacial epochs

As the fold movements which created the Himalaya gradually died down, Arctic cold descended upon many parts of the earth. Much of the northern hemisphere was covered by ice-sheets, which advanced and retreated a number of times, four such advances and retreats being well recognised. The higher portions of the Himalaya were also loaded by ice, from which glaciers descended in many directions. The present landforms in the Himalaya show unmistakable evidences of ice-sculpture resulting from past gigantic glaciers. The present glaciers were, during this ice-age, undoubtedly of mammoth size. They extended down or retreated up the valleys as temperature rose and fell. Generally all the Himalayan valleys of today between two to three thousand metres show glacial features, such as, U-shaped valley forms, hanging valleys, truncated spurs, old massive end moraines and abandoned lateral moraines. The altitude at which they are observed depends upon the vertical movements to which they were subjected after they were formed. Such forms are seen on both sides of Pir Panjal, in the Sind and Liddar valleys in Kashmir, in the upper Ravi valley in Chamba, in Beas valley in Kulu and in the various tributary valleys of Ganga, such as Mandakini, Alakananda and Pindar

### Indo-Brahm River

As a compliment to the rise of the Himalaya from the Tethys due to great tectonic stresses, there occurred a depression to the south of the new mountains. An arm of the sea occupied this gap between the Vindhya Kaimur scarp and the foothills of Himalaya in the Eocene epoch. In this sea were deposited nummulitic rocks, today found





scattered from north-west Punjab to Uttar Pradesh. This sea gradually gave place to a broad estuary in which flowed a river named Indo-Brahm by Pascoe. The valley of this ancient river extended from Assam to Punjab. The Murree and the Siwalik series of rocks are supposed to have formed in this valley.

Differential earth movements disturbed this drainage in the mid-pleistocene when a slight upward rise along the Aravalli axis divided it into two. A complex system of river captures occurred, subsequently, in north-west Punjab. The Soan river consisted of the present Upper Chenab and the Upper Jhelum. A double beheading by tributaries of the west flowing portion of Indo-Brahm diverted the uppermost portion of Soan into Chenab and the middle portion into Jhelum.

Ghaggar river which flows today near Chandigarh and disappears south-westwards in the sands of Rajasthan was also perhaps a large river. Multiple beheading of this river near Dagshai reduced its Himalayan catchment. A portion of its upper course was captured by Sutlej, whose middle course is a part of the old Indo-Brahm. A tributary of the Ghaggar was further captured by Yamuna. Many complex river captures also occurred in Uttarakhand and Nepal Himalaya.

In the east, two rivers falling into the Bay of Bengal which may be called Proto-Ganga and Proto Brahmaputra captured the eastern portions of the Indo-Brahm at the present elbows near Rajmahal and Dhubri.

A great Tibetan river is also supposed to have flown in the present Sindhu-Tsangpo furrow. The barbed tributaries of Tsangpo in Tibet support the theory that it flowed towards the west. But the direction and sharp bends in the rivers Shigar and Shyok in Kashmir suggest an eastward flow, though here also two dominant directions of portions of these rivers can be explained only by river capture. The Tibetan river, therefore, either flowed through Pamir towards Iran, or to the east along the

Mekong or Yangtse river valley. Its Tsangpo portion was, however, captured by the ancient Surma river by headwater erosion, which in turn was beheaded by the Brahmaputra.

### Antecedent Drainage

The rise of four major rivers of northern India, Sindhu, Sutlej, Karnali ( Ganga ) and Brahmaputra near Manasarowar on the Tibetan plateau, and their subsequent entry into the plains of India through deep transverse gorges, has been explained by calling them antecedent to the rise of the Himalaya. The Sindhu rises in the region north of Kailash mountain. The Sutlej rises in springs west of Rakshash Tal and Manasarowar, which have perhaps an underground connection with Sutlej. Karnali rises in a spring named Mapcha Chungo, south-west of Manasarowar. The Brahmaputra rises in glaciers on the northern flanks Himalaya east of Manasarowar.

Many other streams also have most probably cut back through the Himalaya by headwater erosion, such as, the Jadh Ganga in the west and Subansiri in the east. River Arun cutting through a deep gorge between the Everest group ( Maha Langur Himal ), and Kanchanjangha Group ( Kumbhakarna Himal ) two of world's highest peak groups, has perhaps captured a good portion of the drainage of Tibet. All these cases may also be explained by antecedence.

Photu pass in Nepal above the source of Kali Gandak may be called a wind gap through which a portion of the Tibetan river may have escaped southwards at sometime.

*The Sindhu-Ganga trough* was slowly filled by numerous tributaries of Sindhu and Ganga, which eroded the mountains with increasing speed as every uplift of the Himalaya rejuvenated them. Emerging from their steep mountain courses, they discharged their burden of silt in the plain, which slowly became a flat, level stretch of alluvium, which is about 5,000 metres deep in the centre.

Gravimetric surveys have revealed structural ridges and domes at the base of the alluvium. This has led to exploration for mineral oil in the Bengal basin, underneath the alluvial blanket. The junction of the trough at its northern end with the Himalayan foothills consists of a series of long parallel fractures of the nature of a boundary fault. Fractures of a similar nature perhaps lie concealed under the alluvium further south. They form seats of earthquakes, some of which are very severe and destructive, such as, the great Bihar earthquake of 1935, the Assam earthquakes of 1891 and 1955, and the Kachh earthquake of 1958. The epicentres of these earthquakes lie in the seismic belt of India along the northern edge of the plains.

#### Karewas of Kashmir

At the beginning of the Pleistocene, a slight rise of Pir Panjal, which was then a low range, resulted in an obstruction at Baramula and the consequent filling of the Vale of Kashmir by a large lake named Karewa. Subsequent movement made the surrounding ranges higher and the lake bed deeper, in which fluvial, fluvio-glacial and morainic materials, were deposited. The nature of deposits varied according to change in the climate and the rise of Pir Panjal. The lake level also fluctuated accordingly and was further controlled by the erosion at the outlet near Baramula.

The Karewa beds are nearly 2,200 metres thick. After the draining of the lake, erosion is gradually removing them from the central part of the valley. But the outer fringes of nearly half of the valley are still covered by Karewas, which stand out as platforms projecting from the mountain rim, and presenting inward facing scarps.

• Similar lacustrine beds of Pleistocene age also occur in the Kathmandu basin and Pokhara valley in Nepal, where the Baghmata and Seti Gandak were obstructed by the

rise of Mahabharat Lekh, creating lakes, which were drained later on.

#### NOTES

1. Wadia, D N. : GEOLOGY OF INDIA.
2. Krishnan, M. S. : GEOLOGY OF INDIA AND PAKISTAN.
3. Gansser, A. : GEOLOGY OF THE HIMALAYAS.

## Physiography and Landforms

The great size of the Indian sub-continent, its three major physiographic regions, namely the stupendous folded ranges of north, the great alluvial plain of the centre and the ancient crystalline plateau of the south, its varieties of climates, past and present, providing all types agents of denudation, have resulted in a great variety of landforms, practically every type, which is found elsewhere in the world. We find innumerable types of combinations of geomorphic process, stage and structure, which produce these landforms. Himalaya stands as the centre-piece in the north. Its physiographic region are described below.

*The Northern Mountain Wall :* This group of Chains of fold ranger extending north of the subcontinent for over 3,000 kilometres, may be further subdivided into three main regions, the western ranges flanking the north-western border of the subcontinent, the great northern arc, made up of the highest ranges of the world and the eastern hills, not so high but covered by dense forests, which make movement very difficult.

*The Western Ranges :* This region includes the semi-barren ranges, and hill valleys of the north-western border of the subcontinent, spreading fanwise or in loops and chains from the Makran coast of Baluchistan to the higher ranges of Swat, Chitral and Gilgit.

*Baluchistan :* The hills and ranges of Baluchistan may be taken to spread up to the Gomal valley, which may be conveniently taken to divide the region into two halves.

The focus of the ranges is Quetta in the Bolan valley, where are found the highest peaks of the region, Zarghun

and Khilafat, both nearly 3,500 metres high. From round about this pivot the ranges spread out like a great fan to the west, south-west and south on one side, and south-east and east in Zhob and Loralai.

Along the northern frontier of Baluchistan are Chagai Hills rising over 2,300 metres, to the east of which the salt marshes of Hamun-i-Lora are fed by Pishin Lora. To the west there are a number of volcanoes. Here Koh-i-Malik Siah, rises in Koh-i-Sultan peak a dead volcanic cone, to a height of 2,500 metres. The dry climate and extreme temperatures control the denudational processes, which, as in nearly all dry climates have helped in the production of a series of talus cones along the bases of the hills, spreading out on barren expanses of clay and sand. Wind erosion is more prominent and it cannot transport the vast accumulation of debris. Anticlinal ridges and synclinal valleys prevailing in the tract are due to ribs of hard limestone and absence of normal erosion by water.

Hamun-i-lora is more salt encrusted and dry, rather than a marsh. North of this line of hills are the depressions of Zirreh and Seistan in Afghanistan, fed by Helmand river. This lakeland is more damp and provides water for wheat, barley and fruit gardens. The ruins of old cities and a dam across Helmand ( Band-i-Rustam ), indicate the past prosperity of this tract.

South of Chagai range lies the crescent shaped basin of Hamun-i Mushkel. The depression sinks to about 1,000 to 500 metres, between high sharp cested ranges. It is covered by barren shifting sands, with small strips of cultivable alluvium along wadis. River Mashkel and its curvilinear tributaries, running between Siahan Ranges to the south flow into the Hamun (Playa). The massive Makran Hills run nearly parallel to the coast and enclose within them trellised drainage patterns of river Dasht and its tributaries, flowing in eroded anticlines, as the soft, tightly folded hills have easily yielded to erosion. The foothills are cut up by ravines in clay rocks, while the

hills rise in fantastic pillars and pallisades of many coloured layers showing all conceivable forms of aeolian erosion. The longitudinal ranges produce a Dalmation type of coast, with T and L shaped peninsulas and bays, the most typical being Gwadar.

South of Quetta and Sibi the ranges run north-south, and bulge out in a loop eastward near Karachi at their southern end, cutting off and limiting the flood plain of Sindhu. The most striking feature of these ranges is the easternmost scrap of Kirthar range rising 2,600 metres in the north. It is cut through by the Gorges of Mula and Gaj rivers, and the parallel ranges include the longitudinal valleys of Hab, Purali and Hingol. The ranges enclose the cool plateau of Kalat, which was the seat of the Khan, or the ruler of Kalat. At the mouth of Puran, a fan like alluvial plain provided a site for Las Bela state. These hills and ranges are also full of small valleys chocked with talus fans.

East of the Quetta pivot the ranges sag southwards in the form of a Hammock whose two ends are 'tied' to the peaks of Zarghun and Takht-i-Sulaiman (3,800 metres). In between the ranges are enclosed the trellised stream patterns of Beji. The valley of Zhob, a tributary of Gomul and the Toba Kakar Range on frontier fit into the pattern.

Valley deepening is much more pronounced than valley widening all over this arid region, resulting in canyons, the most conspicuous being the Chhappar Rift on the Harnai route to Quetta. Incidentally, this route is more important than the Bolan route, while the frontier is 100 kilometres further north of Quetta, near Khojak pass leading to Kandahar in the Arghandab valley.

The fans and loops of hills and ranges in Baluchistan have been shaped by sharp projecting ends of the Gondwana foreland lying underneath the Sindhu Alluvium. Two such points of resistance are in the Nari valley near Sibi and the Gaj gorge.

No complex structure of recumbent folds is observed in Baluchistan. The folds have been spilled over southwards and eastwards on the edges of the hidden plateau, in simple synclines and anticlines, which remain as valleys and ridges in many places even today.

North of the Gomal valley the ranges are higher and more complex. But the valley itself provides an important gap in the mountain wall through which a route passes to Ghazni, which was the leading centre of Muslim potentates in the past. The Sulaiman Range continues northwards across Gomal and Tochi, which cut transverse gorges through it. Tochi and its tributary Kurram provide two more passage-ways westwards. While the Sulaiman Range runs north-south, the Salt Range, which is the southernmost bulge of the Himalaya in the western flank of the syntaxial bend near Abbotabad, presents a scarp southwards, running more or less east to west. The scarp, however, loops northwards, when it crosses the Sindhu at Kalabagh, and again southwards at the Pezu gap, through which the strategic railway line to Tank passes. It encloses the Bannu plain, watered by Kurram and Tochi.

Another east-west trending range, and more prominent than the Salt Range, is Safed Koh, extending north of Kurram and the small Kohat basin across the Sindhu as Kala Chitta Dhar, finally joining the pivot at Abbotabad. It drops in height in its middle portion to 1000 metres or less, but rises at both ends to greater heights. In the west it culminates in Sikaram peak rising over 5000 metres in Parachinar. The loess covered plateau of Potwar is enclosed between these two ranges and the rivers Sindhu and Jhelum. It is drained by Soan, which was a large river in the past, being now reduced to its present size by a double beheading by Jhelum and Chenab.

Dryness is still the key note of the landscape. Near Taxila the brown and reddish hills are scantily covered by thorn bush. People prefer to live in the cool retreats of



caves dug into the hill. The topography around Tochi and Kurram valleys is a tangled mass of arid hills, as a result of the clash between the north-south folds of Sulaiman Range and the east-west folds of the Himalayan extension of Kala Chitta Dhar—Safed Koh and the Salt Range.

North of Safed Koh is the valley of river Kabul, the largest western tributary of Sindhu. Through this valley runs the famous Khyber pass route, just over 1,000 metres in height, and about 50 kilometres in length. The Kabul valley opens out in a fertile basin around Peshawar.

North of the Kabul valley the pivot is in Pamir, at the northern tip of Chitral. From here, ranges much higher than those south of Kabul valley, spread out south and south-westwards into Afghanistan. In between them are the valleys of Swat and Kunar, northern tributaries of Kabul. The upper Kunar valley and its enclosing high mountain ranges lie in Chitral, which has an extremely rugged topography of deep gorges and valleys and towering snow-clad ranges. Tirichmir the highest mountain peak of Pakistan, over 8,000 metres high stands here. The Swat valley is less rugged and not so remote as Chitral. The valley is connected to the deep trench of Sindhu to its east by Malakand pass.

### Northern Mountain Arc

This region includes mainly the Great Himalaya Range and its ramifications. Ranges parallel to it running to its north and south are also included in this region. To its west and east are the great syntaxial bends with Nanga Parbat and Namcha Barwa as their pivots.

*Karakoram Range* : This range is only second in height to the Himalaya for it boasts of nearly 50 peaks rising above 7000 metres, which include  $K_2$  (nearing 9,500 metres,) the second highest peak of the world, and the Gasherbrum group of four peaks, all above 8,500 metres,

But the whole range and its ramification spread over a high plateau like base, no where below 3,500 metres. The ridge tops may rise more or less 2,000 metres above the valley bottoms, while in the Himalaya this difference may be 4,000 metres at many places. For example, at Bunji, the bed of Sindhu is only 1,200 metres, while its valley sides rise up to 6,000 metres. Again the Arun gorge below Mt. Everest gives a similar contrast. The Karakoram ranges, therefore, look much more subdued. But their great altitude and higher latitude keeps them permanently in the grip of snow and ice. The valleys are not of rivers but glaciers. So the leading agents of erosion are frost and ice. The ridges are sharp aretes and the peaks are horned. The slopes are concave. K<sub>2</sub>, or Mt. Godwin Austin very much resembles Matternhorn in shape. It is also formed of limestones, like Everest. Landforms resulting from active glacial erosion, are the chief components of the scene.

The glaciers of Karakoram are some of the largest mountain glaciers in the world. They are always overlaid, and completely covered by rock debris and moraines. This is due to fierce rock shattering and disintegration by frost, producing huge masses of weathered material; which can be transported by glaciers, only slowly. The snouts of the glaciers are choked with tremendous heaps of end moraines. Water erosion is nearly absent, and wind can carry away only fine material. The movement of the glaciers is generally very slow, hardly 50 centimetres per day. This may be controlled by topography, and the extent of supply from fern basins. In lower portions of the larger glaciers, even some grass, and stunted conifers may grow on the moraine cover, where shepherds encamp with their sheep. Transverse tributary glaciers descending from steeper slopes, may advance more rapidly.

Further down near the snout, water pours out from ice caverns, running deep under the ice as englacial rivers.

Small lakes are also formed on the glacier surface and specially at the edges behind lateral moraines.

There are proofs of the retreat of the glaciers in Karakoram in the form of large abandoned lateral moraines on the sides, and huge deposits of end moraines below the snout, at places covered by the present outwash, or overgrown by grass.

Siachen, the longest glacier is 70 kilometres long. It gives rise to Nubra, a tributary of Shyok. Biafo, Hispar, Baltoro and Baturo are other giant glaciers of Karakoram, which are 40 to 60 kilometres long.

Further down in the lower ablation zone, slow ice movement and little precipitation explain the presence of vast quantities of debris, as there is slow removal of rock waste accruing from the very active weathering processes. This is specially so on the northern slopes of Karakoram, where glaciers flatten out and discharge streams, laden with outwash, over huge accumulations of moraines and talus cones.

To the south of Karakoram are the valleys of Gilgit, Shigar and Shyok. River Gilgit flows through a basin of the same name, in the north-western corner of Kashmir. The enclosing mountain walls of the basin tower high over the valley, culminating in the east in Rakaposhi, another peak over 8,500 metres high, and the Haramosh group with the highest peak rising over 8,000 metres. In the mountain fastnesses north of Gilgit is the isolated, rugged grandeur of the territory of *Hunza* a tributary of Gilgit. The base level of erosion of river Gilgit is its junction with Sindhu above Bunji, which is hardly 1,400 metres high. So the central portion of the valley lies at an average height of 1,600 metres, where spread the barley fields and orchards along the river terraces 3 to 6 kilometres wide and 30 kilometres long.

The *Shigar* and its tributaries rise from large glaciers mentioned earlier. The volume of water in them depends much upon insolation. A hot sun may easily produce a

miniature flood. Another character of these valleys are elongated gravel filled basins in the thalweg, produced in true glacial rock basins, or lacustrine deposits in lakes produced by dams of ice or moraines. Lower down in *Baltistan* the rivers flow on broad gravel beds, while flanking desolate scree slopes rise up on both sides to jagged snowy ranges, on which cling corrie glaciers.

Further east are the valleys of *Nubra* and *Shyok* which provide a passage over Karakoram from Kashmir to Sinkiang. Here the landforms resemble those in Shigar, but further east near its head the Shyok valley broadens out to the high, flat, desolate, wind-swept plain of Depsang. In the valley at one place two side glaciers intermittently advance and dam the river. The ice dam bursts when the weight of water in the temporary reservoir is too much, producing minor floods down the Shyok and Sindhu. South of Depsang a similar desolate waste is called Lingtzi Tang Plain. At its western edge the last spurs of Karakoram gradually subside and in between are shallow valleys of Chip Chap, Galwan and Chang Chen Mo all falling into the Shyok. There is not much difference between the valley bottoms and the interfluves, and the relief is subdued. But the altitude of the whole tract is very high, being more or less four to five thousand metres all over. The whole region is strewn with gravel and boulders, which were perhaps dropped from thick ice sheets which covered the plains and melted in situ. The high plateau gradually sinks to the plain of Aksai Chin in the north-western corner of Kashmir. Here encrustations of soda around some salt lakes, or in other depression, has given it the name of Soda plain.

The divide between Shyok and the Indus rises as a snowy range some 300 kilometres long. It continues as Kailas range in Tibet. North of it across the border an elongated depression is filled by Pangong Lake fringed by vast scree slopes, gravel and boulder beds. It was, in all probability a river valley which joined the Shyok,

which was separated from it by the accumulation of debris.

### The Sindhu Furrow

South of Ladakh Range the Sindhu river flows in a deep and broad furrow, throughout the length of Kashmir. The bed of the valley is above 4,000 metres near the Tibetan border, and slowly sinks to 3,500 metres below Leh which is situated on the plateau above the gorge. At Khalatse bridge on the Srinagar-Leh road the altitude is 2,500 metres.

The whole region in this upper Sindhu valley in Ladakh may be taken as a bleak high plateau upon which are embossed a series of mountain chains, and which is in the process of dissection by the Sindhu and its tributaries. In spite of the great altitude the relief is much less than that observed in the Great Himalaya and its southern flanks.

At Skardu the Sindhu drops further and flows over a broad flood plain near its junction with Shigar. It enters a deep rocky defile at Rondu, and flows through perpendicular walls of rocks rising 2,000 metres on each side, for 80 kilometres, before it opens out near its junction with Gilgit. Further down it flows in a flood plain two to three kilometres wide amidst the rugged forested hills of *Kohistan* in Pakistan.

## The Great Hill Range

*1. Western Himalaya :* This mightiest range of the world is anchored in the north-west in the mass of Nanga Parbat peak, reaching 8,126 metres in height. Large glaciers descend down from these heights, such as, Diamir and Rakhiot to the north and Bazin to the south. As they descend steeply they are full of crevasses and ice-falls. Western Himalaya may be taken to extend from here up to Kali gorge on Nepal border.

The valleys on the northern slopes of Himalaya have many subsequent streams developed into strike vales, such as that of Astor and South Shigar, which joins the consequent river Dras. Zaskar river and its tributaries have developed a rectilinear pattern in this manner.

The general slope towards Sindhu is gentle, and some places have developed into level stretches of land, as the Deosai plain, between Astor and Shigar, the latter developing a dendritic pattern on the plain.

But the most important physical fact about this region is its high altitude. The Deosai plain is on an average 4,500 metres high. The town of Dras stands at a height of 3,500 metres, and between it and Karcha stream, the slopes of Himalaya are covered by small and large glaciers, amphitheatres and tarns. Further south-east the landscape continues to be of the same type. Here Doda a subsequent tributary of Zaskar flows in a U-shaped valley, and is fed by numerous glaciers from the northern slopes of the Himalaya. The largest of these glaciers is Durung Drung which is 22 kilometres long. The triangular basin of Padam at 3,700 metres is formed by thick deposits of outwash brought by Doda and other glacier-fed streams,

and is a huge complex of fluvio-glacial fans. A combination of these streams forms the Zaskar which flows down to Sindhu below Leh. Zaskar range runs in between these valleys, parallel to the Himalaya.

South-east of Padam is Rupshu, a high snowy waste, with a large lake, Tso-Morari in its centre. The land forms here are similar to Ladakh. Tso-Morari has a salt-encrusted rim, like the lakes of Aksai Chin and Lingtzi Tang. All these lakes show features of dessication in the post-glacial period. A raised beach 14 metres above the present water level of Tso-Morari is a proof of its former extent. Now the lake is 24 kilometres long and 3 to 8 kilometres wide. Situated at a level of 5,000 metres its surroundings are a desolate waste of rocks, boulders and gravel.

Further south-east the central axis of the Himalaya comes very near the Tibetan border in Himachal Pradesh and Uttar Pradesh. There are no other parallel ranges north of the Himalaya, such as, Zaskar, Ladakh and Karakoram in Kashmir.

River Spiti drains the snow-melt water of the glaciers of this tract into Sutlej. This inaccessible high valley beyond the crest of the Himalaya is a geological museum, exposing nearly all systems from palaeozoic and mesozoic rocks exposed in bare cliffs and scarps.

The Sutlej rises near Rakshash Tal, with which it seems to have an underground connection. It then flows through a one thousand meters deep canyon in Nari Khorsum ( in Tibet ) before it enters India at Shipki, and then after joining Shipki cuts through the central Himalayan range in a tremendous gorge, and proceeds further in a deep trench throughout its mountain course. In Garhwal and Kumaon in Uttar Pradesh the axis of high peaks, Kamet and Nanda Devi both above 8,000 metres is far the close to the Tibetan Border. It continues nearly along the southern border of Tibet, further east up to Assam.

South of the central axis of the Himalaya a number of parallel ranges may again be recognised, the most conspicuous among them being Pir Panjal, nearly 400 kilometres long and stretching from Jamgarh peak (4,700 metres) west of Kishen Ganga, through Kashmir, Chamba and Kulu to Deo Tibba, where it merges with the Great Himalaya range. Its crest is more or less covered by perpetual snow, and is seen stretching from east to west as a dazzling array of silvery peaks from the plains of Punjab.

The enchanting vale of Kashmir, an oval shaped basin, covering some 4,500 square kilometres, lies between the Great Himalaya and Pir Panjal, longitudinally, having its larger axis spread in 120 kilometres from south-east to north-west. Its centre is covered by lakes and marshes. The largest of them is Wular lake, 14 kilometres long and 4 to 7 kilometres wide. It is the largest natural lake of sweet water in India. Around the lake is the flat alluvial basin created by Jhelum and its tributaries, nearly 1,600 metres high. It is ringed by platforms of fluvio-glacial Karewa beds, nearly on all sides. Limestone caves and voluminous springs, such as those at Verinag (Source of Jhelum) Achhabal, Anantanag, Martand and Chashma Shahi (in Srinagar) are found near the edges of the valley. Among the caves may be mentioned those of Martand and the holy cave of Amarnath in the upper Sind valley.

To the north of the vale of Kashmir, Sind, Liddar and other streams descend from the snows of the Great Himalaya to the Jhelum. There are many glacial lakes and trans in their basins, such as, Shesh Nag, Tar Sar and Gangabal, all situated above 3,500 metres. Other glacial features met with are hanging valleys, U-shaped valleys with truncated spurs, moraine deposits and rock steps over which rivers tumble down, such as, the West Liddar near Zoipal and Sind, below Sonamarg, where the vale of Thajewas joins it. The biggest glacier in this tract is Kolahoi coming down from the Kolahoi peak, 5,425 metres high in Liddar valley.



The northern slopes of Pir Panjal are covered by morains on which grassy meadows called Margs have developed, such as, Gulmarg, Khilanmarg, Tosha Maidan and Yusmarg.

Among the highest peaks of Pir Panjal in Kashmir are Tatakuti (4 750 metres) and Brahma Sakli (4,700 metres). The Jhelum cuts a deep transverse gorge in Pir Panjal below Baramula, and flows down in a trench to the plains of Punjab. The sharp bend of the river at Domel conforming to the Syntax is noteworthy. The Chenab similarly cuts a gorge through Pir Panjal below the terrace of Kishtwar. East of this point Pir Panjal rises in height and forms a divide between Chenab in the north and Ravi and Beas in the south. It culminates in Deo Tibba, which together with two other peaks rises to 6,632 metres.

Glacial features like tarns, U-shaped valleys and hanging valleys are found at many places near the crest. The tarns of Rupri, Bhag Sar being the biggest, and the hanging valleys in the glaciated valleys of Betar and Girjan on the southern slopes are worth mentioning. All these are imprints of the past glacial epoch.

Parallel to Pir Panjal, south of it, there is another conspicuous range named Dhaola Dhar, which has its beginnings in Kashmir. Here Chenab runs between these two ranges below Kishtwar for a considerable distance and has developed a series of river terraces on both its banks. The *valle of Bhalarwah* is situated here on the obsequent river Neru-Dhaula Dhar may be taken to continue as Ranjoti ridge westwards across the deep Chenab gorge at Riasi towards Domel vertex. It consists of an inlier of limestones and dolomites which rise abruptly in steep crags through soft sandstones, to peaks often above 2,000 metres. Rivers cut canyon-shaped defiles through the ridge. The springs of Punch and *Tattapani* (hot water) are associated with the limestones. The name Dhaola Dhar is given to the range east of Patni Pass, over which the Jammu-Srinagar road passes. The secluded *valley of*

*Chamba* lies here between the two ranges towering above it and ending in the snowy, glaciated basin of Bara Bangahal, where high spurs of both the ranges meet. This tract is drained by Ravi, which flows in a gorge below 1,000 metres and has broad flanking terraces at Chamba. The ridge crests rise steeply on both sides from four to six thousand metres. Further east, river Beas flows and cuts another spectacular gorge through Dhaola Dhar at Larji, about 20 kilometres long. Above the gorge are the terraces of Kulu valley. Here again, above Manali glacial features like truncated spurs appear. At Koti, river Beas cuts through an extra-ordinary cleft hardly 20 metres broad and 300 metres deep down a major rock step. Above it, the valley has a broad open U-shaped cross-section. The range continues as a high, snowy crest north of the Sutlej gorge below Simla, and crosses it further east. Here between it and the Great Himalaya range near the border is the glaciated, subsequent *Baspa valley*, fed by glaciers on all sides. It is four to five thousand metres high, and is surrounded by snow covered mountains. The Baspa joins Sutlej near Kalpa in Kinnaur.

Beyond Baspa the Himalayan ranges enter Uttar Pradesh. The Central high Himalayan axis runs very near the Indian border and is drained by glaciers and streams, which are sources of the Ganga. Yamuna the main tributary of Ganga rises in a defile from a hot spring below the cliffs of Bandar Punch group of peaks rising 6,315 metres high. Its tributaries Tons and Giri drain the area further west in a rugged inaccessible mass of tangled hill ranges.

The biggest glacier here is Gangotri, 30 kilometres long and 5 kilometres wide, fed by a system of tributary glaciers, namely Chaturangi, Rakt Baran, Swet Baran, Nilambar, Pila Pani etc. denoting a variety of colours. This glacial basin is four to six thousand metres high, and is surrounded by peaks rising like dazzling pinnales of

silver seven to eight thousand metres in all directions. The highest of these is Chaukhamba (four pillars) or Badrinath (7,138 metres). Shivling has a most striking appearance, shaped like a steep conical spire and called as Matterhorn in a nightmare. Other peaks are Kedarnath (6,940 metres), Sumeru, Basuki and the Gangotri group further down. Bhagirathi or Ganga issues from the snout at Gaumukh, charged with much pulverised outwash. Another tributary of Ganga is Mandakini, which rises from a small glacier named Chorabari on the southern face of Kedarnath peak, cuts a gorge through a huge moraine platform, deposited in the past, and joins Alakananda at Rudra-Prayag. Alakananda and its other head-waters, are fed by glaciers on the eastern flanks of Chaukhamba, Nilkanth (another silvery spire) and the western flanks of the Kamet (7,756 metres) group of peaks. Alakananda itself rises from the combined snout of Bhagirath Khark and Satopanth glaciers. Hanging glaciers, huge accumulations of moraines, frost shattered peaks and hanging valleys are a feature of this tract.

The biggest and highest group of peaks, however, is further east, where Nanda Devi soars to 7,816 metres in its "Sanctuary" surrounded by an array of glittering peaks, such as, Trisul, Dunagiri, Nanda Ghunti, Mrigathuni and Maiktoli. Huge glaciers descend steeply from these peaks on all sides.

Pindar, another tributary of Ganga, rises from Pindari glacier filling the saddle between Nanda Devi and Nandakot. Along 15 kilometres of its upper course hanging valleys tumble down into it from mountains rising high above in sheer cliffs. Pindar joins Alakananda at Karna Prayag, and further down, at Deva Prayag, Bhagirathi joins it forming river Ganga, which issues forth from the Himalaya at Rishikesh.

Glacial lakes are found at many places in this tract. Worth mentioning among them are the tarns of Basuki Tal above Kedarnath temple, Lok Pal in Bhyundar

Ganga valley and Rup Kund below Nanda Ghunti. Gohna Tal above Nanda Prayag is formed by moraine plugging. Another feature of the slopes below the snow line are grassy meadows between three and four thousand metres, called Bugiyals, such as, Baidini Bugiyal below Rup Kund, and Martoli Bugiyal and Reta Bugiyal below Pindari glacier.

South of Pindar, a prominent feature is Dhakuri range which runs east-west from near Rudra Prayag to Gwaldam and Dhakuri, and then curves northwards to join Nandako. peak, 6,861 metres high. Important passes over it are Kuari, Gwaldam and Dhakuri. It is a watershed between Pindar Ganga which flows into Alakananda and Sarju, which joins Kali river on the border of Nepal.

Dhakuri range is three to four thousand metres high. Rivers Gori Ganga and Darma Ganga flow southwards from this tract rising in glaciers on the border. Of these Milam glacier to the east of Nandakot is most prominent. All these rivers flow through deep trenches to the Kali gorge which separates India from Nepal. The route to Manasarowar and Kailas follows Kali from Tanakpur to Lipu Lekh pass. Here small amphitheatre like basins in small tributaries of Kali, such as at Champawat and Pithauragarh, are noteworthy. Between these two basins is the subsequent valley of Sarju. Garur, a small tributary of Sarju drains another alluvium filled basin at Baijnath before it joins Sarju near the crescent-shaped terrace of Bageshwar. The Kali flows down to the plains as Sarada below Tanakpur.

The upper slopes of the Great Himalaya range in Uttar Pradesh have been great centres of pilgrimage from ancient times. This tract as a whole, is referred to as Uttara Khand in the scriptures. Nearly all the rivers of this region rise in high snowy regions, but they drop down in the short space of about 200 kilometres, from these great heights to the plains, much unlike the main rivers of Kashmir, Himachal Pradesh and Punjab, which have long longitudinal courses

in the mountains. They, therefore, plunge into trenches which go below 1,000 metres, often within 50 kilometres from their sources. Hence this tract is extremely rugged. The small basins mentioned earlier and river terraces along are sites for villages and intensive agriculture.

2. *North-eastern Himalaya* : South of Dhaola Dhar and Uttara Khand, there are no conspicuous ranges up to the longitudinal valleys called Duns. Here the ridges gradually rise north-eastwards in height from one to two thousand metres, with some peaks reaching three thousand metres, providing an escape from the hot plains of north India in summer, and easily approachable, many hill stations were developed here by the British.

In the extreme north-west of the Punjab, hills rise steeply to over 2,000 metres and consist of sharp-crested ridges, over-grown by pine and Deodars, which are specially dense near Dalhousie situated on a spur of Dhaula Dhar dividing Ravi and Beas valleys. Beyond it across a 3,000 metres high pass is the amphitheatre and tarn of Khajiar at 2,600 metres altitude, a relic of past glaciation. The tarn is situated in a circular meadow with a mountain rim covered by Deodars (*Polyalthea longifolia*). A floating island of reeds in the lake adds to its beauty.

The Dhaula Dhar rises abruptly from the plains of north Punjab, and its glistening snow peaks can be seen from the Kulu-Kangra road along the edge of the plain. Dharamsala, another hill station is situated here amidst pines at 3,500 metres, immediately below snow peaks soaring to more than 5,000 metres. This juxtaposition of snowy ridges and undulating plains, with a relative difference of 4,000 metres is seen nowhere else in India. This type of topography is best revealed from the Rest House at Baijnath situated above an incised meander of a tributary of Beas.

Near Mandi a spur named Ghogar Dhar runs parallel to the main range, enclosing within it a strike vale named Uhl. Another strike vale is Rana Khad enclosed by a

similar spur. The Beas cuts awe-inspiring gorges through these spurs above and below Mandi. The spurs present scarps outwards and dip-slopes inwards. Advantage is taken of the topography by dropping the water of Uhl through a tunnel into the Rana Khad gorge to produce hydroelectricity. South of Mandi is a large alluvium filled basin, which is intensively cultivated.

In the surrounding hills is situated Rawalsar lake in an amphitheatre. It is famous for its seven floating islands, and Hindu, Sikh and Buddhist temples.

The gorge of Beas through Dhaula Dhar at Larji is most impressive, the side walls rising a thousand metres in sheer cliffs.

Further south-east is Sutlej valley passing in a deeply cut gorge between the tangled hills of Bilaspur to the North and Simla to the south. There are many broad river terraces developed along the river, such as, at *Tattapani* (hot springs) below Simla. The broad terrace on which Bilaspur town was situated is now drowned by Govindsagar reservoir above Bhankra dam. The dam is located at the upper end of a large loop created by Sutlej, whose two arms flow along the strike, and the head cuts through a ridge. Tributaries flowing along the strikes join the parent river below Bilaspur and again below Nangal.

Simla Hills are situated between the gorge of Sutlej and Giri, a tributary of Yamuna. They consist of a tangled mass of confused ridges, spurs and peaks forming a major water-parting between Sindhu and Ganga. The first ridge rises abruptly from the plains above Kalka to Druid's peak (1,927 metres) and Monkey point both above 2,000 metres, at Kasauli, a pine clad hill station.

The middle and the most conspicuous ridge in this tract is Panchmunda, which drops down at Sabathu. It is pierced by a railway tunnel near Barog, one and half kilometres long. On its southern face a line of springs is found along a junction of clay rocks with sandstones. A pipe line has been laid to tap them. While one spur

from Panchmunda goes east towards Chail, another goes north joining with the Simla ridge.

Throughout this tract, the ridges, which are nearly always sharp-crested, rise to about 2,000 metres, while the valley bottoms, all V-shaped and flowing through interlocking spurs, are often below 1,000 metres.

Simla ridge stands just south of the Sutlej gorge. It culminates in the two peaks of Jako (2,205 metres) and Prospect hill. The ridge continues to follow south of Sutlej to Mashobra, Narkanda and beyond. It forms a water parting between Sutlej and Giri, an affluents of Yamuna. It is more or less a transverse ridge, created by erosion.

3. *South-eastern Himalaya* : The Yamuna valley of the ranges south-east of Simla are dominated by the granite peak of Chaur, 3,647 metres high, with a centrifugal drainage. From it starts the Nag Tibba range running south-east through Nag Tibba peak (3,022 metres) and beyond. It passes in a crescent shape through the middle of Jaunsar-Bawar hills between Tons and Yamuna. Here it culminates in the limestone peaks of Deoban (2,951 metres) and Kharamba (3,071 metres) above Chakrata. South of Chaur is the longitudinal valley of lower Giri, which capture the upper Giri in a perfect elbow east of Solon. Near Dagshai, a few kilometres further south is a wind gap, through which the upper Giri joined the Ghaggar, a mighty river of the past. Parallel to the Nag Tibba range, south of it, another longitudinal range called Mussorie range may be recognised. The Yamuna and the Tons cut transverse gorges through these ranges and join at Kalsi. 12 kilometres below the Giri joins the Yamuna above Paonta. Here and further east the open longitudinal valley of Dehra Dun between Mussoorie range and Siwalik range becomes a major topographical feature. It is drained by Asan to the west into Yamuna and Song to the south-east in Ganga. The Southern face of Siwalik range is very badly eroded into steep ridges and valleys,

while the northern face slopes down gently to the Dur Song is supplied by the waters of Guchhupani or Robber's cave, a cleft in limestones. Small stalactites are noted in the hills around Dehra Dun, specially at Guchhupani and Tapkeshwar. The height of Mussoorie is also due to its being made up of limestones, the highest peak Landour rising to 2,266 metres straight above the plains of Dehra Dun. Small caves with stalactites and craggy formations are also found around the town.

*The Ganga Valley :* The Ganga comes out of the Himalaya at Rishikesh, and then cuts across the Siwalik Range at Hardwar. The temples of Manasa Devi and Chandi Devi are situated near the Siwalik crest and the goddesses which the Hardwar gap through which the Ganga flows. There are flat topped spurs above the Dun, where villages are located. Narendra Nagar is perched upon one such flattened spur. There is much terrace development in the Bhagirathi valley from Dharasu to Tekri. A beautiful incised meander occurs in the Bhagirathi at Malideval, a few kilometres above Tehri.

There are many large terraces in Alakananda valley also from Pipalkotni to Kirtinagar. The biggest terraces are at Ganchar and Srinagar. The Nag Tibba range continues through this region.

Ram Ganga a tributary of Ganga flows in a transverse gorge through the Himalaya, but creates a small Dun just above Kalagarh, where it cuts through the Siwalik range.

4. *Lower Himalaya* : The lake land of Kumaon on the part of the lower Himalaya is characterized by a large number of mountain lakes, which attract many tourists. The most beautiful of them is Nainital. Other lakes are Bhimtal, Nankuchia Tal, Sar Tal, Garal Tal and Khurpa Tal. To them may be added a dry depression Sukhe Tal near Nainital. Here again the British established a cantonment, because of the sudden height above 2,000 metres so near the plains. This is due to limestones of the Krol series occurring here over-riding the Siwalik series



which are separated by a boundary fault. China peak (2,600 metres) itself is made up of limestone. The crags of Deopatha, another peak nearby are also made of limestone, and below it Sukhe Tal is limestone depression, resulting from solution. The lakes are, however, supposed to be formed by post tectonic slips and mass sliding or gravity gliding according to Thomas (1952). This is a kind of adjustment of movement. However, the effect of limestone on landforms cannot be denied. The great depth of Khuirpa Tal and Nainital is a point in question. The rivers Ram Ganga and Kosi, and their tributaries cut up these hills into jumbled mass. The valleys flow through deep gorges, but there are river terraces and talus cones in the valleys and spurs with level tops above. They are seen in Kosi and its tributaries between, Nainital and Almora.

5. *Central Himalaya* : This portion of the Himalaya lies mainly in Nepal, spreading a long way further from the Kali valley to the west to the Kanchanjunga massif and the Mithi valley to the east. Here one can recognize a number of parallel physiographical zone very clearly. The most important is the Great Himalaya, which extends from Nanda Devi massif in India to Api ( 7,132 metres ) in Nepal and further east to Dhaulagiri ( 8,172 metres ). Annapurna ( 8,078 metres ), Everest ( 8,848 metres ) and Kanchanjunga ( 8598 metres ). Beyond this wall of snow, the highest in the world are comparatively flat lands, called Inner Himalaya by Tony Hagen, and bounded on the border by a snow water-parting between the Brahmaputra ( Tsangpo ) and the large tributaries of the Ganga, namely the Ghaghra, Gandak and Kosi, whose headwaters have penetrated across the Great Himalaya, and sometimes even across this water parting into Tibet, as Karnali, an affluent of Ghaghra and Arun a main tributary of Kosi.

In the middle of Nepal runs a more or less continuous range, named Mahabharat Lekh, which is an equivalent

of Pir Panjal in Kashmir and Nag Tibba range in Uttarakhand.

The hills and valleys, comparatively less rugged lying between the Great Himalaya Range and the Mahabharat Lekh have been called the Midlands by Tony Hagen.

South of this range the hills drop down to a series of longitudinal Dun like valleys, here in general called Bhitri Madhesh. Some of these are the Rapti, Dang, Chitawan, Narayani (specially developed in its tributary called Rapti again), Kamla and so forth.

South of Bhitri Madhesh are the Siwaliks, here called Churia or Muria or Churia Muria ranges. At places this range coalesces with the Himalayan ranges, where they overthrust southwards upon it as below in Nainital. The most well developed Dun is the Narayani-Rapti Dun just north of Valmikinagar, previous named Bhainsalotan, where the Narayani or Gandak cuts across the Siwalik range.

A clearer idea of the lay of the land will be obtained by describing the three large river basins, the Ghaghra, the Gandak and the Kosi, otherwise called western, central and eastern Nepal.

*The Ghaghra Basin :* In the north-western corner of Nepal are the Api and Nampa massifs, among the glaciers of which rises Seti the westernmost river of the Ghaghra system. It takes sharp turn to the east, passes below Silgarhi Doti and joins the Karnali, the longest river of the system. Among the various rivers which form the Ganga, Karnali has the largest and the most marked upper course in Tibet, and is recognised as one of the four antecedent rivers. It rises in the springs of Mapcha Chungo south of lake Manasarowar in Tibet and flows eastwards past Gorla Mandhata (7,728 metres), and then between to snowy ranges into Nepal. It turns and twists peculiarly, specially below Sirkot, where it travels 30 kilometres south-east, cuts a transverse gorge and sharply turns to the north-west to join Seti. Another very long tributary of Karnali

is Panjang which flows through a glaciated valley westward. Karnali has thus a very large glacial catchment. Another very large river is Bheri, which drains the northern face of Dhaulagiri massif (7,639 metres) and joins the combined Karnali and Seti. The river ultimately pierces through Churia Range below Gairdākanda to come out in the plains as Girwa and Kausiala, which is called Ghaghra further down.

*The Gandak Basin :* The main river of this basin is Kali or Krishna Gandaki which rises beyond the main Himalayan axis in Manang Bhot. It is definitely antecedent to the Great Himalaya, which it pierces in a fantastic gorge between Dhaulagiri (8,172 metres) and Annapurna (8,078 metres), scarcely 35 kilometres apart, the level in the gorge at Dana being only 1,200 metres.

The scene in Manang Bhot is open and more like Tibetan landscape. Here Gandak runs through a rift valley and cuts a deep gorge in thick young Tertiary rocks, and quaternary sediments of a lake.

The Great Himalaya here consists of a number of very high snowy arcs called "Himals" in Nepal. In Gandak valley there are at least four Himals, namely, Dhaulagiri, Annapurna, Manaslu and Ganesh Himals.

South of Annapurna Himal a snowy spur extends southwards and forms a magnificent horned peak M. Chhupchhare of "Fishtail mountain." From it descends Seti Gandak, which flows through the vale of Pokhara, which is formed by the bed of a past lake. This lake was formed by the sudden rise of Mahabharat Lekh, which cuts off the passage of Seti Gandak. In this lake were deposited fluvio-glacial materials from the surrounding mountains. Phewa Tal, a large lake in Pokhara valley is perhaps a remnant of the past lake. The valley is a flat piece of land nearly 15 kilometres long and 6 kilometres wide. The lacustrine deposits consists of soft limestones and conglomerates. Numerous large boulders of granite, gneiss and schist are embedded in the lake deposits. There are

subterranean caves in the limestones, such as, Mahendragupta, fantastically narrow gorges and river terraces in the valley.

An important tributary of Gandak is Marsiyandi, which flows north of Annapurna, and turns south between it and Manaslu. It then joins Trisuli, which comes from Ganesh Himal. The combined Gandak now cuts through Mahabharat Lekh. It flows through a very well marked Dun type longitudinal valley, the Chitawan Dun. It ultimately comes out of Siwalik range at Balmiki Nagar, previously called Bhainsa lotan. Here it is called Narayani, due to the ammonite pebbles found here, which are worshiped as *Narayan Shila* (symbol of lord Narayana). The Dun is drained by the river Rapti, south of which the range is called Churia. Here there are a number of smaller longitudinal ranges, such as, the Sameshwar range along the Nepal border.

*The Vale of Kathmandu* : Besides the three great river basins Ghaghra, Gandak and Kosi, another important physiographic feature in the Central Himalaya is the Vale of Kathmandu, a nearly circular piece of flat land, with a radius of about 15 kilometres, ringed by hills on all sides. It is drained by the sacred river Bagmati, which has a centripetal drainage, the waters running in from all sides, even from south to north, to wash the steps of the shrine of Pashupati Nath, and then to cut a gorge through quartzites and limestones at Chhobar to escape to the plains. Outside the ring of hills the Trisuli and its affluents drain to the west to Gandak, and the Indrawati and Sun Kosi to the east.

The valley is another example of the formation of a lake in between the Himalayan folds and its consequent emptying. Here again the Mahabharat Lekh, during its rise, cut off the Bagmati to produce the lake, in which thick deposits of sand, clay and marble were laid. Eventually the Bagmati cut across the quartzite ridge at Chhobar to allow the waters of the lake to escape. In legends of Nepal it was the Goddess Manjushree, who cut the ridge with her

sword, and made of a gift of the emergent vale of Kathmandu to people of Nepal.

The Karewa like lacustrine deposits are found all over the valley, now being eroded and washed away by the Baghmata and its affluents. The sandy beds in them act as aquifers, and are sources of numerous springs, which provides sites for villages and irrigate paddy fields.

*The Kosi Basin :* Ten kilometres north of Chatra gorge and the temple of Barahakshetra is a point from where three rivers fan out, east, west and north, like the branches of a tree. The combined river issues forth southwards as the broad sandy valley of Sapt Kosi. The river to the west is Sun Kosi, the longest of the western tributaries of Kosi, rising in the snowy heights of Gosainthan ( 8,031 metres ). After collecting the waters of Indrawati and other streams from the outer rim of Kathmandu valley it joins Bhola Kosi near Ramechhap. Bhola Kosi is fed by the snows of Cho-Oyu ( 8,171 metres ) and Gauri Sankar ( 7,145 metres ). Further east is Dudh Kosi which gets its waters from Mt. Everest ( 8,348 metres ) the highest peak of the world. The top half of the pyramid like Everest is made up of limestones, while the lower half consists of phylites and granites. We may imagine a continuous spread of limestones in the past over crystalline rocks in the Greater Himalayan region. It was subsequently removed totally by erosion, except in the highest peak, such as, Everest. The other peaks of granite and other crystalline rocks very nearly reach the base of the now eroded limestone sheet. Below Everest, to its south, a huge bowl of ice, carved out by glaciers descending from peaks which ring round it, Everest, Lhotse and Nuptse. It is a giant amphitheatre, nick-named *cwm* by Swiss mountaineers. From it drops down the wierd tangle of an ice-fall at the head of Khumbu glacier. Signs of shrinking of this glacier can be easily noted in left out lateral moraines. Further down is Namche Bazar the home town of Sherpas, famous high mountain porters.

To the east of Everest is the Arun gorge, one of the most dramatic clefts of the world. Its bottom is only 3,500 metres high as compared to Makalu towering to 8,481 metres above it. The Arun has a fairly large basin in Tibet revealing its antecedent nature. One of its tributaries is Barun which rises in Barun glacier, descending from Makalu. It flows through a large U-shaped valley. The Everest-Lhotse-Makalu massif has been named Maha Langur Himal.

Tamur, the eastern tributary of Kosi rises in the western flank of the Kanchanjunga group of peaks and the Singalila spur descending southwards and forming the eastern boundary of Nepal. South of Tamur Mahabharat Lekh is quite clearly defined, but south of this range, east of Sapt Kosi, the Siwalik range and the Dun valleys disappear. A number of rivers descend southwards, such as, Burhi, Lahandara, Bakra and Mechi, which turn eastwards to join the Mahananda.

6. *Eastern Himalaya* : This portion of the Himalaya may be said to have its western boundary along the boundary of Nepal and the eastern end in the Massif of Namcha Barwa, 7,755 metres high, in the bend of Brahmaputra in Tibet, its counterpart in the west being Nanga Parbat in the bend of Sindhu. It contains Sikkim Himalaya, Bhutan Himalaya and Assam Himalaya. A small part of it in the Chumbi valley, lying between Sikkim and Bhutan belongs to Tibet.

7. *Sikkim and Darjeeling Himalaya* : This portion of the Himalaya consists mainly of the basin of river Tista, and its tributary Rangit, and is bound by two north-south transverse ranges, the mighty Singalila range to the west crowned by the Kanchanjunga group of peaks and the serrated Dongkva range to the east, crowned by Chomo Lhari (7,314 metres). The Great Himalaya Range runs east-west to the north of this region, with a small portion of Sikkim lying north of its axis.

The highest and the most dominating portion of this

region, physiographically, is to the north-west. A large number of peaks above 7,000 metres stand here in a cluster, the highest being Kanchanjungha (8,598 metres), the third highest peak of the world. From Darjeeling it looks as a magnificent back-drop consisting of Jano, Kabru (7,338 metres) Kanchanjungha, Pandim (6,709 metres), Narsing (5,831 metres) and Siniolchu (6,815 metres). Tourists gather in the cold morning hours on the top of Tiger Hill (2,567 metres), 11 kilometres away to watch the Sun rise in the plains of Cooch Behar, and send its pink rays, even earlier to illuminate these peaks, when it is dark in Darjeeling. The crest of Singalila runs through these peaks, which are from north to south Jonsang Peak (7,442 metres), Pyramid peak (7,365 metres) Kanchanjungha, Kabru and so forth. On the same range are the peaks of Singalila (3,679 metres) at the north-western corner of Darjeeling district, Phalut (3,596 metres), Sandakphu (3,323 metres) and Tanglu (3,063 metres). The Kanchanjungha group of snowy peaks is called Kumbhakarna Himal.

The crest of Himalaya runs eastwards near the northern border of Sikkim through Khangchengyao (6,889 metres) and Pauhunri (7,128 metres), where the Dongkya range ends. A number of glaciers descend eastwards from Kanchanjungha, the biggest of them being Zemu, from whose snout above Lachen Gompha (monastery) rise the Tista. It is joined by Lhonak river from the north. River Lachung rises from Pauhunri and joins Tista at Chumthang. A magnificent view of Kumbhakarna Himal is obtained from Singhik only 2,000 metres high perched over a ledge above the roaring torrent of Tista another 1,000 metres below. The view is obtained up the Talung river and glacier, with the snowy Talung peak (7,351 metres), in the foreground. The distance of Kanchanjungha from Singhik as the crow flies is hardly fifty kilometres. From here one can also view the razor sharp range of Dongkya 25 kilometres away up the Tista, which bends here to the north-east. Straight north from here

one can only see Lama Anden (5,867 metres) just south of Lachen.

The contrast between the depth of the Tista gorge and the Kanchanjunga only 25 kilometres away is tremendous. There are two important passes across Dongkya range just over 4,000 metres from Sikkim to Chumbi valley in Tibet. The southern, lower portion of Singalila range is drained by Rangit a big tributary of Tista, which joins Tista near Tista bridge. In this lower part of the valley there are very well developed terraces in the Tista valley. First the terraces appear very near the river, and as the river digs down lower, the terraces which are at the same level, seem to hang high above the valley bottom.

In the Darjeeling district the tract east of Tista consists of a 3,200 metres high peak, with centrifugal drainage all round it into the affluents of Tista and also Jaldhaka to the east. West of Tista there is a marked east-west ridge through Tiger Hill to the Singalila a ridge near Sukia Pokhri. From Tiger Hill a spur goes to the north on which is situated Darjeeling, and another to south called Dow Hill. Here rise Mahanadi and Balason, which flow southwards to form Mahananda.

8. *Bhutan Himalaya* : This part of the Himalaya lies much unexplored, specially its portion to the north, consisting of an area of the Great Himalaya Range running from Choma Lhari (7,314 metres) in the west, through Kulha Kangri (7,541 metres), the highest peak of Bhutan to a peak 6,270 metres high. There are no large river basins in Bhutan as in Nepal. A number of rivers rise in the snowy heights in the north, the biggest of them being the basin of Manas, a tributary of Brahmaputra, in the eastern part of Bhutan, where little is known about the physiography of this remote tract.

On the western border, the Amo Chhu enters, from Chumbi valley in Tibet, through a deep gorge, in Bhutan. It enters Jalpaiguri district as Torsa, which has earned the bad name of being "Turbulent", as it descends from the



great heights of Bhutan as a ferocious torrent, specially during the rainy season.

Further east the Paro Chhu and the Wong Chhu join at what has been called the "Confluence", where the new road from India bifurcates. The combined river runs down to the plains as Raidak.

The next great gorge is that of Mo Chhu, which flows past the basin of Punakha, deep in the mountains, and comes out as Sankosh in the plains.

9. *Assam Himalaya* : This part of the Himalaya is also very little explored, though after the Chinese intrusion in Indian territory, first in Ladakh and then in this area, increased its importance. Yet facts about its physiography are little known. Here the Himalaya gradually curves north-eastwards, as it does north-westwards in Himachal Pradesh and Kashmir. But while there are a number of ranges in the west, there are very few of them in the east. Only the Great Himalaya Range is conspicuous. There is no Siwalik Range, and Middle Himalaya is also not clearly distinguishable. The Great Himalaya forms the international border more or less, but its last end extends into Tibetan territory up to Namcha Barwa around which the Brahmaputra turns sharply. However, some rivers get across it into Tibet. The headwaters of Manas also do so north of Tawang near Bum La. In the centre a branch river, the Subansiri, enters Tibet near Migyitun piercing through the Himalaya. The Subansiri has a fairly big catchment in Tibet. Two of its tributaries—Yume Chu and Chayul Chu—also enter Tibet. This triple penetration is a clear proof of the antedecence of Subansiri. That Brahmaputra is antecedent is a well established fact, and so it should not be taken as a boundary for the Himalaya, which may be taken to extend further east beyond Dihang or Siang, as the main stream of Brahmaputra is called here. In this north-eastern remote corner of India are two more rivers which join Brahmaputra or Dihang near Sadiya. They are Debang or Sikang,

Lohit and Noa Dihing. The Lohit again enters Tibetan territory at Rima, and goes far into Tibet. In all probability it is also antecedent. Thus there are no less than four antecedent rivers penetrating Assam Himalaya—Manas, Subansiri, Brahmaputra and Lohit.

The north-eastwards curve of the Himalaya begins at Kangto (7,089 metres) group of peaks. There are three more peaks in this group, standing on the border, nearly 6,500 metres high. South-west of it in a high longitudinal valley is Tawang monastery at a height of 3,050 metres. Here east of it are high longitudinal valleys of Bichom and Tenga with very high ridges in between. Here is Sela (pass) more than 6,000 metres high. This ridge may be taken as a counter-part of the Middle Himalaya. River Kameng rises in the Kangto group of peaks, and joins Bichom before coming down to the plains. Over the next ridge to the south is Bomdi La, about 3,000 metres high. The Middle Himalaya continues through the Subansiri basin and continues with interruptions perhaps up to Bruini in the upper Dibang valley. New roads are now being built into these deeply forested virgin hills and valleys to points like Bomdi La and further up to Dirang, Hapoli near Zéro, Pangin and Poing.

### The Eastern Hills and Ranges

The hills and valleys in this region may be supposed to begin south of Noa Dihang. They have a general NNE-SSW trend and extend through Naga Hills, Manipur and Mizo Hills into Burma as Arakan Yoma. They may be taken as the eastern boundary of the Indian Sub-continent. A plateau from these hills extends east-wards as Meghalaya Plateau, which is not produced by Himalayan orogeny, but is an inlier among the Ganga, Brahmaputra sediments, of the Deccan Plateau. A portion of it appears as the detached Mikir Hills.

*Patkai and Naga Hills* : These hills run in a north-east south-west direction roughly along the Burma-India border.

There highest portion lies in the extreme east in the finger-like protrusion of the Indian territory. Near here a peak on the border is 3,856 metres high, but they loose height west-wards where a road was built across them near the end of the second World War, later called the Burma Road. South of it a peak on the border is 2,243 metres high. The hills broaden out towards the south around Kohima, where height also increases. The highest peak of this region is Japvo (2,995 metres high). East of Kohima, is Mol Len peak (3,104 metres). The river valleys in the hills are usually longitudinal. Though the height of these ridges is very moderate, yet the topography is extremely rugged alternating with steep ridges and deep gorges.

*Vale of Manipur* : This is another lacustrine basin, which formed among the folds of the Eastern ranges. The flat basin is drained southwards by river Manipur, which joins the north flowing Myittha in Burma to join the Chindwin. The vale has an altitude of about 1,000 metres, whereas it is surrounded by hills going upto 2,000 metres here and there. The central part of the vale is a marsh with a shallow lake named Loktak,

The marginal hills to the east drain directly into Chindwin. The hills to the west have a marked trellised drainage, which approaches the Appalachian type, long well-marked longitudinal valleys running north-south, finally draining out to the Surma valley plains.

*Mizo Hills* : This drainage pattern is more pronounced in the Mizo hills and the adjacent hills of Tripura and Chittagong Hill Tract to the west and hills of Burma up to Arakan Yoma. In Mizo the ridge crests are about 2,000 metres high, while the valley bottoms are below 500 metres. Both these heights decrease to the west. The grain of the country is north-south and the rivers and ridges all run north-south. It may so happen that in parallel valleys hardly ten kilometres apart the rivers may run in opposite direction. They cut transverse gorges now and then through the ridges.

The valleys to the north Tuivai, Sonai, Dhaleswari and Gutur drain towards the Surma valley. The highest peak is Nauzuarzo (2,140 metres), The Kaladan and its branches drain the southern Mizo Hills to the south towards Burma. The tributaries of Karnaphuli make an ideal trellised pattern of drainage and the consequent river cuts through ranges transversely into Pakistan.

*Mikir Hills* : This hilly area is a good example of circumdenudation, where a portion of the crystalline plateau has been detached from the adjacent Meghalaya block by the rivers Dhansiri and Jamuna-Kopili. It has more or less a centrifugal drainage, the highest peak in the centre being Dambukcho (1,363 metres). Another high peak is Chenghehishon (1,359 metres).

*Meghalaya* : Along with Mikir Hills, this plateau is a continuation of the Deccan Plateau, and is obviously connected to it underneath the spread of Ganga alluvium in the Bengal plains. Physiographically, however, it belongs to the Eastern Hills. The average height of the plateau is 1,500 metres. The highest point, Shillong peak is 1,961 metres high. The top of the plateau has a rolling topography, while its edges drop down steeply, specially to the south, where there is an abrupt drop of 1,000 metres to the plains of Sylhet. The plateau is in the process of dissection, and the valleys have produced a rolling topography in the central portion, but the edges are being deeply notched, specially at the southern edge, where yawning gorges have cut into the plateau. Water-falls descend into these gorges, such as, Mawsmi Falls in the south near Cherrapunji and Bishop and Beadon Falls in the north near Shillong. The central portion is made up of crystalline rocks and granites at many place, and the bouldery rolling landscape has resulted due to them as at Umtyingar.

Around Tura in the west there is again a slightly high area left out by erosion by rivers all round it. Here, Nokrek peak is 1,412 metres high.

## Glaciers and Glacial Geomorphology

Himalaya being the biggest mountain of the world, the glaciers also are the largest. Baltoro, Biafo and Siachen glaciers in the Karakoram range are such giants. Among other glaciers of Himalaya one may note Gangotri, Bhagirath Kharak, Sona, Khumbu (below Everest) and Zemu (below Kanchanjunga). Glaciers which have been much visited by tourists are Pindari in Garhwal and Kolahoi in Kashmir

### Pleistocene Glaciation

It is a well-known fact that Pleistocene Glaciation and its four phases—Gunz, Mindel, Riss and Wurm have played a leading role in the development of glaciers and glaciated landforms in the present day world. The Himalayan landscape is no exception to it. However, the processes of glacial erosion have been applied here on the mightiest mountain of the world, consequently the glacial geomorphology has some new and extra-ordinary features.

The landscape in the Higher Himalaya near or above the snow line, at a height of about 4,000 metres or more, shows unmistakable signs of the work of past giant glaciers. A very common feature is the existence of tremendous cliffs of bare rock, often polished and striated flanking the high peaks covered by eternal snow, and soaring to great heights. They are the work of ancient giant glaciers which truncated the great spurs of the high peaks. They are most conspicuous between 3,500 to 4,500 metres. Near the snouts of these glaciers and for some distance below, they produce huge U-shapes, such as near Vasudhara above Badrinath. The "Sanctuary" of Nandadevi is

surrounded by these cliffs and they successfully disallowed mountain climbers to enter the sanctuary, until Tillman found a route into it from Lata Kharak in 1935. One can have a nice view of these cliffs from Pindari glacier. Above their tops hanging glaciers discharge water falls into the valley below. All the area around Badrinath including Rishi Ganga, Alakananda and Saraswati valleys the high cliffs rise steeply, surrounding Nar, Narayan, Nilkanth, Bangneau and other peaks. Right in front of Badrinath to its east a large hanging glacier Kuber comes down in a great sweep from the slopes of Nar Parvat and is poised above a 700 metres high rock cliff. A waterfall descends from its tip. As it protrudes over the cliff it occasionally breaks down and sends an avalanche, which thunders down to the base of cliff. Vasudhara and many other falls are of a similar nature. Steep rocky cliffs formed by truncation are also found in Kashmir in the upper Liddar and Sindh valleys. They are very impressive on both sides of Mahagunas pass on the way to Amarnath.

### Horned Peaks

Above the protecting ramparts the high mountain peaks are often shaped into fantastic spires and cones by excessive frost shattering. Some of these are far more impressive than the famous Matterhorn, as for example, Shivling rising above Gaumukh, which has been called "The amazing Matterhorn peak of India" by J. A. K. Martin. It has defied all attempts to scale it up-till now. Other perfect horned peaks are Amadablam, below Everest, Machhapuchhare dominating Pokhara valley and Nilkanth, nicknamed the "Queen of Garhwal". Machhapuchhare has been compared to Matterhorn by Tony Hagen.

### Cirques

Just below the peaks are found cirques, some of them being of very large dimensions, such as the CWM below Everest, surrounded by Lhotse, Nuptse and Pumori. The

interior of the Nandadevi Sanctuary is also a big cirque, which opens out through the deep gorge of Rishi Ganga. An impressive cirque is situated to the north east of Sheshnag lake in Kashmir, surrounded by Trimurti peaks. A smaller cirque of exquisite beauty is situated below Mahagunas, east of the path to it. It is a perfect amphitheatre gauged in the snowy watershed between Liddar and Sindh. Beyond there is another big cirque supplying water to a source stream of Sindh, when snow melts. Below it is the great bowl of Panchtarni, from which another big cirque may be seen to the east. Panchtarni itself is now a flat oval surface which might have been a gigantic cirque in the past, followed by the creation of a glacial lake, which drained off later on. Its exposed bottom at present forms a level surface covered by sand and gravel brought by Sindh, and surrounded by fluvio-glacial terraces. The lake was formed by an old terminal moraine plug at the lower end of the Panchtarni flats. Many more cirques are also found in West Liddar valley, around Kolahoi peak, and on the flanks of Harmukh. Bodkol or Madmati takes its rise below a cirque on the western slope of Harmukh.

Other cirques of even larger dimensions are found further below those mentioned above. They were formed in the Pleistocene by giant glaciers which had descended down to nearly 2,500 metres. The large undulating bowl of Badrinath is one such cirque created in the past in all probability. It was later on choked and filled up by huge amounts of glacial till brought down from above. Six kilometres above it there is a smaller bowl around Mana, which is also filled up by till, through which Alaknanda and Saraswati have cut gorges, leaving wide terraces on all sides. The temple of Kedarnath stands in the centre of another huge bowl levelled up by till. Dr. Fritz Muller in his account of research in the Everest region observed several large deposits of debris and was impressed by "the new forms and dimensions" of the Himalayan scene. He

adds, "In the Dudh Kosi valley I was amazed by the numerous quaternary deposits and the immense moraine on which the idyllic monastery or Thyangboche (4,000 metres) stands."<sup>1</sup>

### Glacial Lakes

Another feature of glacial topography are a variety of lakes. Tarns or small circular lakes near or above the snow line are found scattered nearly all over high Himalaya. Some well-known tarns are Rupkund on the outer slopes of Nandaghunti, famous for the skeletal remains found near it. Lokpal in the valley of flowers in the Bhyundar Ganga valley, Vasuki Tal above Kedar Nath, Ala Pathri above Khilanmarg in Kashmir, Bhagsar and about twenty others bear Rupri in Pir Panjal, Cangabal and other tarns below Harmukh and Tarsar and others in West Liddar valley.

Some of the lakes were formed by plugging of valleys by moraines brought and deposited by ancient glaciers. Sheshnag in East Liddar valley is also such lake, while there are many others. Chhangu lake in Sikkim has a similar origin. Lakes are sometimes formed between outer lateral moraines of the glaciers and the rock cliffs. A good example of such a lake is Satopanath Tal below Chaukhamba. There are examples of rock basins in the valleys from where the glaciers have now melted away. But these have been filled up by the large amount of sand and gravel brought by the rivers. Jhala and Dharali rock basins are good examples of this phenomena in the Bhagrathi valley. North of Indus and east of Shyok, high plains are frequent such as the Depsang Plain, the Soda Plain, Lingtzitang, Chang Chenmo and Pangong. There are numerous salt lakes in this region. All this area is strewn with rock debris, gravel and boulders, which is the end product of disintegrated ranges of the past, a sort of a frost action<sup>2</sup> peneplain. Further, in all probability, an ice cap enveloped it during the Pleistocene glaciation. As it



waxed and waned from temperature fluctuations, it behaved like a giant sand paper. The ice cap perhaps melted and dropped the glacial debris it carried on the ground. The result was a general levelling, and much disruption of drainage, producing shallow lakes. Pangong lake is one such lake, which obviously was a part of Shyok river earlier. There are many other salt encrusted lakes, such as, Tso Morari in Rupshu.

### Periodicity in glacial phenomena

There is a certain periodicity of snow, ice or glacial movement by gravitational pull. Ice does not flow like water, but moves down in jerks. Temperature fluctuations or earthquakes may accelerate the downward movement of accumulated ice. The rate of snow precipitation also is another factor. When the accumulation of ice or snow reaches a critical limit on a slope, it breaks asunder and thunders down as an avalanche. It, therefore, occurs after a certain period along a favourite route. Badrinath town has been destroyed by big avalanches descending down from Narayan Parvat after every fourth or fifth year. It is quite probable to predict the catastrophe if a scrutiny of all previous such avalanches is made, for a large period.

The most interesting phenomena of periodicity of glacial movement is the formation of a glacial dam by Chong Kumdan glacier across the Shyok river, nearly after every fifty years, forming the Gapshan lake. The phenomena has been fully studied by Kenneth Mason. The previous advances were in 1832-33, 1876-77 and 1923-24. Kenneth Mason has predicted the next advance in 1968-69.

### Schollen Movement

Glacial valley development passes through a number of stages in the Himalaya. Two types of glacial movements were recognised by Finsterwalder and Pillewizer. They applied terrestrial photogrammetry to determine movements of glaciers. The first kind of movement according

to them was Fedchenko type of very slow movement, producing marked bands of medial moraines. The second was a steeper faster movement typified by Rakiot glacier descending north of Nanga Parbat. Here the velocity was about 800 metres per year, forcing the ice downwards, not flowing but tumbling in blocks or "Schollen" or ice-clods. Chong Kumdan glacier is also of this type. J. B. Auden noted Schollen movement in Khatling glacier astride the watershed between Harshil and Gangotri. Enquiries from local people revealed that a short-cut route was used by pilgrims in recent past between these two places along Khatling glacier. But Auden believed that the condition of the glacier, when he visited it, was so terrible that it could never be used as a pilgrim route. He, therefore, concluded that the glacial valley form had changed from a smooth slow motion to the Schollen type. It is reasonable to conclude Schollen movement comes at a later stage in the glacial valley from development. As the slope of the glacier increases it assumes the shape of an ice-fall. One can clearly notice the Schollen type of movement in the upper portion of Satopanth glacier. The huge steps of ice blocks are supposed to be those of the stair-case to heaven over which the Pandavas ascended. From Badrinath a small hanging glacier with Schollen movement is observed south of Kuber glacier descending from Nar Parvat.

Before proceeding to a discussion of cross profiles of glaciers and glaciated valleys below the snouts it will be profitable to note the significance of rainfall records, giving an interesting precipitation profile across the Himalaya, taken by Dr. Fritz Muller. His conclusion was an "unexpected aridity" of the Everest region. The total precipitation at 5,300 metres from 12th April to 26th November was only 39 centimetres on Khumbu glacier as compared to 199 centimetres at Chisapani in Middle Himalaya and 225 centimetres at Sirha on the Ganga plain.

He arrived at the very important conclusion, affecting

geomorphological processes in High Himalayas that "Slow ice movement and little precipitation explain the vast quantities of debris in the lower ablation zone, as there is a correspondingly slow removal of great masses of rock waste accruing from the very active weathering processes<sup>2</sup>". This logic if applied to the giant glaciers of the Pleistocene age explain the occurrence of huge accumulations of glacial till. Other factors to be remembered are the continuing shrinkage and decay of the present glaciers and the puny size of the present glaciers as compared the past giants.

### Lateral Moraines

The usual pattern of the cross profiles of the glaciers of medium size consist of multiple lateral moraines or medial moraines, which coalesce further down to provide a complete cover for the glacial ice. The outer lateral moraines are often quite conspicuous. They often form sharp concave ridges, which suggests that they are at present not features of accumulation, but erosion. The glaciers have sunk between them due to recent shrinkage. There is usually a well marked trench between the cliff like flanks of mountain sides and the outer faces of the moraines. This is explained by supposing that the present glaciers are riding over thick deposits of convex shaped ground moraines of the past large glaciers. This fact is well illustrated by Bhagirath Kharak glacier, a source of the Alakananda river. Arnold Heim and A. Gansser in their book on Central Himalaya hold a similar opinion.

Broad glacial terrace like features are also found along the sides of glaciers. They may be remnants of ground moraines of the same glacier when it was higher, broader and bigger. So their origin is somewhat similar to river terraces. They form extensions of talus cones spreading over them. Erosive action of wind, water and snow, sometimes makes them very smooth. Such a terrace is found spreading along the northern edge of the Bhagirath

Kharak glacier. The terrace is cut up at places by intermittent stream courses. Some streams disappear in the loose gravels and reappear at the lower edge of the terrace as springs. In shaded sides of the glaciers, different features may be found. On the southern side of Bhagirath Kharak, below Balakun, the climate is arctic as compared to the warm temperature on the northern side of the glacier. Here instead of talus cones are couloirs made by snow slides from above. As this side is mostly frozen the supply for lateral moraine material is negligible. In fact, the southern lateral moraine disappears in the upper part of the glacier. Talus cones are smaller and fewer. The same is the case in Satopanth glacier south of

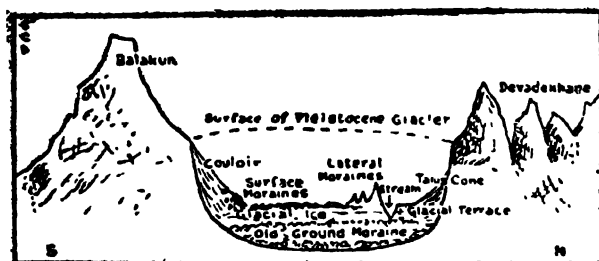


Fig. 1

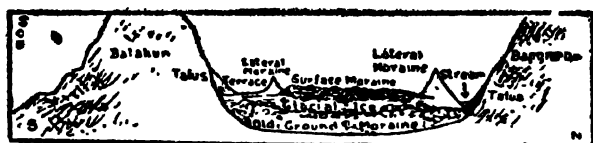


Fig. 2

Balakun. Here talus cones are very conspicuous on the southern sunny slopes of Balakun. There has been heavy frost action and rock shattering in the Devadeknane area north of Balakun across Bhagirath Kharak. The snow shattered peaks rise like so many spires of ice and rock producing a lunar landscape. The partly snowed up rock spires of Baguion above Vasudhara falls also look alike.

Section across the Bhagirath Kharak in Figures 1 and 2, and across the Alakananda in Figures 3 and 4 illustrate these phenomena clearly.

**Retreat of Glaciers :** Practically all the Himalayan glaciers have been slowly retreating in the present times. The lower ends of many glaciers are in the stage of final disintegration. This is so in the case of Satopanth and Bhagirath Kharan glaciers. Just above their snout the ice is very thin and is completely covered by surface moraines. This was noted by Heim and Gansser. The moraine cover is pock marked by circular funnel shaped depressions. There is a continuous rumbling noise due to collapsing of the moraines.

### Old terminal moraines

A very common feature below the snouts of many glaciers, or near the ends of glaciated valleys is a conspicuous terminal moraine about a hundred years old. It lies

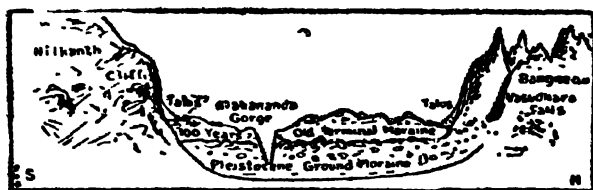


Fig. 3

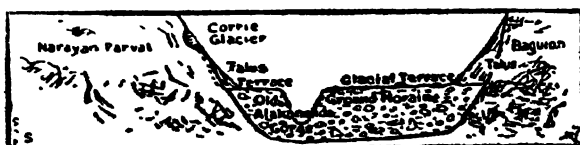


Fig. 4.

transverse to the valley, where it is found, is often grassed and is about 150 metres high. It nearly shuts up the valley in question. The present river cuts a gorge through it. This feature is very prominent near Vasudhara near the source of Alakananda valley (Fig. 3). A very similar feature is found blocking the Rishi Ganga above Badrinath, which again cuts a gorge through it. An exactly similar feature is found above Sheshnag lake in the East Liddar valley in Kashmir. Yet another such feature is found in the Baspa.

valley in Kinnaur. J. F. S. Ottley describes the Upper Baspa valley as "Broad and flat, and bounded by cliffs of brown conglomerate with Chitkul as the first habitation, with evidence that a glacier may have once reached below Chitkul at 4,000 metres, 29 kilometres below the present snout of a big glacier descending from the Nela Pass, which is covered by black moraines". In the upper Baspa valley the river cuts through an old terminal moraine nearly 150 metres thick at the lip of a circular plain which is the bottom of an old glacial lake below village Sangla.

On the other side of the pass to the east in the Jadh Ganga valley. Ottley noted a "Razor sharp black lateral moraine over looking a fine glacial amphitheatre".<sup>3</sup> In the same glacier are moraines, oxidised and crumbling like rotten slag heaps, flanking the oppressive gorge atop which are the glacial steps formed during the Pleistocene ice age. The description of these moraines applies well to those above the snout of Bhagirath Kharak.

### Gangotri glacier

The glacial geomorphology of the Gangotri group of glaciers is somewhat different. The Gangotri glacier and its many tributaries, including Chaturangi, Rakt Baran, Kedar etc., form a complex system of glaciers. Gangotri depicts features of Bhagirath Kharak on a much larger scale. The lateral moraines gradually coalesce. The outer lateral moraines dam many lakes between them and the cliffs. There are also well marked glacial terraces, of which Nandan Ban and Tapo Ban are well known. They provide nice camping grounds. Major Gordon Osmaston described Nandan Ban as "A splendid camping ground with clear streams running through many acres of flat grass-land" at a height of nearly 5,000 metres. The horn of Shivaling rising above Tapo Ban has been described by Marco Pallis as "A horrid looking mountain with a striking resemblance to the Matterhorn, as it might appear in a nightmare."

The snout of the Gangotri glacier has been described by J. B. Auden who gives the conditions in 1934, which differed slightly from his sketch<sup>4</sup> in 1963, as observed by me. The snout is a grey crumbling wall more than a kilometre long and over 100 metres high. The snow caves through which the waters of the Bhagirathi pour out change positions frequently. It changed from west to east in 1963. Below the snout the moraines consist of tremendous accumulations of boulders, the softer materials having been washed away. Bhagirathi does not cut a gorge through older ground moraines, which are found in comparatively narrow bands on both sides of the broad valley. The old lateral moraines stand as gigantic walls of boulders. The till of Pleistocene age has been washed away to a great extent. It is at present sticking at slightly higher levels on the sides of the containing rock walls. While the softer material has been washed away huge fan like cones of boulders called "Rehra" spread out from above into the valley. At places the last remains of boulder clay stand in bunches of earth pillars topped by huge boulders. They are fifty to hundred metres tall, giving some indication of the thickness of the boulder bed from which they have been carved out. Ten kilometres below Gaumukh, near Chirbas there is a huge platform of boulders about 200 metres thick and a kilometre wide. It is in all probability the remnant of a terminal moraine.

The valley form of Bhagirathi from Gaumukh to the temple of Gangotri is wide and has a broad U-shape. It is quite probable that the glacier extended upto the temple, and remained in this position for a long time. Further down the river takes a right angle bend and cuts a tremendous transverse gorge in the granites of the central axis of the Himalaya.

Further down at Dharali, Harshil and Jhala the river bed expands to a broad sandy belt, through which the river meanders. This in all probability is a rock basin, now filled up by sand, a work of the past glaciers. Its

sudden appearance, coming up from Suki, is dramatic. Marco Pallis describes it thus : "From the top of the spur above Suki the eye looks into a new world. The valley is broad and flat, and Bhagirathi flows through it in a wider channel."

*Recent Retreat* : Among the evidences of recent retreat of glaciers are abandoned lateral moraines. They occur at many places. They have been noted in Khumbu and Baltoro glaciers. A pair of abandoned lateral moraines were reported to exist on the flanks of Bilinglampa glacier in Lahul by Sunil Munshi. A very conspicuous lateral moraine abandoned by the Pindari glacier\* named Chhuri Dhar, about two kilometres long and 200 metres high stretches below its snout.

Pindari glacier can be reached conveniently by a good mule track, along which there are staging bungalows. General Strachey visited it in 1847, and recorded its movement<sup>5</sup>. J. W. A. Mitchell visited it in 1884 and 1894, and concluded that the glacier had retreated 100 metres in 10 years. Cugin Brown and Cotter drew a sketch of the glacier in July 1906, and fixed up marks on the rocks to observe changes in it. Saradindu Bose in 1959 by the help of this sketch estimated that the glacier had retreated about 50 metres in 50 years. Contraction has now slowed down due to the present steep and constricted shape at the snout, as seen by me in 1958.

From about three to eight kilometres below their snouts, many glaciated valleys are heavily choked by thick deposits of glacial till, through which the present rivers have cut gorges. This is so, with Alakananda, Mandakini, Pindar and Sind near Sonamarg. Glacial terraces, some times quite big, are found on both sides of the rivers. In the Mandakini valley, just below the temple of Kedarnath, the gorge cut in the loose morainic material extends up to Rambara, five kilometres further down. The gorge is about a hundred metres deep. Many big springs come out from gaping holes in the sides of the gorge. Waterfalls



from hanging valleys drop on sheets of frozen snow and disappear into the moraines. This water comes out in the form of springs. There is a similar waterfall in Rishi Ganga valley above Badrinath, just below Nilkanth spire. The upper portion of Pindar river shows similar conditions near Martoli Bugiyal, down upto Phurkia Dak Bunglow. In the Sindh river below Sonamarg there are large spring holes in the sides of the glacial terraces. When water freezes during winter, they provide safe retreats for flocks of sheep.

The U-shape of the valley cross sections in Kashmir is somewhat modified in many streams at a height of about 3,500 to 4,000 metres, just as in Thajewas near Sonamarg and Amarganga below the Amarnath cave. The shape is a smooth parabola. This is due to a huge and continuous accumulation of talus material, partly frozen.

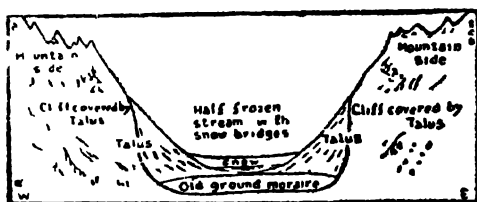


Fig 5

They cover up the vertical cliffs and produce the impression of a parabola. The rivers are partly frozen, and can burrow under snow beds and snow bridges. The main cause of this phenomena is the general principle, stated earlier of a very rapid rate of production of eroded material by heavy frost action, and its very slow removal, resulting in accumulation of huge quantities of debris.

*Longitudinal Profile* - A distinctive feature of the longitudinal profiles of glaciated valleys is the occurrence of step like breaks, often at the junctions of tributaries. Here one notices water-falls, cataracts and rapids in the rivers. Mandakini has such a fall near Son Prayag. In the East Liddar there are two such water-falls above and below the Zojpal terrace. There are rapids in the Alakananda

between Ghat Chatti and Pandukeshwar. River Bhagirathi tumbles over rapids above and below Gangnani. But the most spectacular break is noticed in the Beas river below Koti, where the river drops into a fantastically narrow and deep gorge, and comes out in a flat U-shaped valley just above Bashisht. Here it is joined by two tributaries.

The breaks are explained by greater excavation by glacial ice when its weight suddenly increases by the junction of a tributary glacier. It is also explained by another school by the theory of protection provided by ice and the greater capacity of water in excavating a valley as the snow melts.

Further below the wide glacial till choked valleys, rivers in middle Himalaya enter gorge sections. Here they flow in deep gorges formed by truncation of spurs by the past glaciers, which descended down the valleys upto nearly 2,000 metres. In the upper portions of the gorge sections remnants of glacial till are still noted. They appear in road cuttings, and make stable road making a difficult task. One such deposit opposite the road in Alakananda valley about three kilometres above Hanuman Chatti shows a distinct layer of outwash material sandwiched between two layers of boulder clay. This sequence indicates two advances of glaciers with a warm period in between.

Though normal erosion is busy in obliterating glacial features produced in the past, one can very easily recognise them, when there is a sudden change of scenery of the gorges. The river is entrenched between sheer cliffs of rock rising 500 to 1,000 metres till the shoulders of gradual slope are reached. The U-shape from the valley bottoms is not easily recognised, as the shoulders are too high from here. Moreover, the rivers are busy excavating a V inside the U. This is so at Belakuchi on the way to Joshimath. In between the truncated spurs are truncated valleys, which are called hanging valleys, which drop down

as water-falls in the main valleys. In the Bhagirathi valley this scene comes into view at Gangnani. In Alaknanda valley the glaciated gorge section is very well developed from Belakuchi to Hanuman Chatti. In Pindar river it starts beyond Khati. In Kashmir the glaciated sections come up to the level of the valley. For example, the U-shape is clearly seen a few kilometres above Pahlgam. Here the track to Amarnath zigzags over the face of a truncated spur above Chandanwari, which is called Pissu Ghatti. The truncated spurs and hanging valleys are very well displayed in the Beas valley near Bashisht. Viewed from below they appear like sugar loaf peaks, because the sight line from the valley bottom, does not see the upper

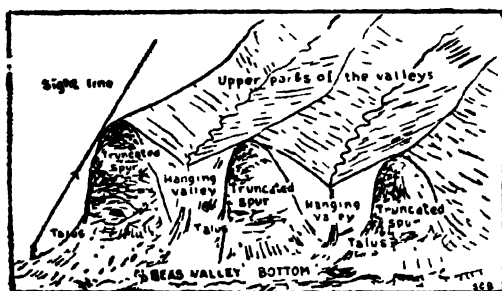


Fig. 6

part of the spur. Their nature is clearly understood as one ascends up above them. They are viewed very well from below Rohtang pass. The same is the case in Alaknanda valley. D.N. Wadia has mentioned the existence of glaciated features in the Betar valley on the south slopes of Pir Panjal near Punch, and at some other places in the Himalaya.

At some places a U is noted cut inside another U. Two distinct shoulders are also noted. This shows that the glaciers advanced, retreated back and again advanced, to retreat back once again. The valley was deeper during the second advance. This may not be from two advances of Pleistocene phases, but temporary fluctuations. There may again be a V being cut inside the two U's.

### Upper Bhagirath and Yamuna valleys

The two chief rivers of the Ganga basin are the Bhagirathi, which is called the Ganga below Deva Prayag and the Yamuna. Rising in the Himalaya near Gaumukh and Yamunotri hardly seventy kilometres apart, they travel nearly 1,000 kilometres to join at Prayag. The colour of the waters of these two rivers is so distinct, the yellowish grey of the Ganga and the blue of the Yamuna, that even where the waters mix they can be distinguished from each other. Perhaps this has something to do with their place of origin.

The Bhagirathi or the Ganga rises from Gaumukh in the snout of the Gangotri glacier, one of the largest glaciers of the Himalaya, 30 kilometres long and 2 to 3 kilometres wide, and joined by a large system of glaciers<sup>6</sup> including Chaturangi, Rakt Baran, Swet Baran, Nilambar, Pilapani, Kalipet, Suralaya, Sundar, Satopanth, Kedar, Sumeru and others. On the other hand near the source waters of Yamuna there is no glacier worth the name. The Gangotri system of glaciers are fed by snows and also huge quantities of debris, resulting from frost shattering among many giant peaks and aretes over six to seven thousand metres high such as Chaukhambe (7,138 metres), Satopanth, Bhagirathi, Chandra Parvat, Basuki, Shivling and Sumeru. The source waters of Yamuna today receive snow melt water and rock shattered debris only from Bandarapunch (6,315 metres) group of peaks.

While the Bhagirathi valley has an open aspect above Gangotri, the morainic material which must have choked it in the past is being rapidly washed away. In the bottom and lower sides of the valley the clay and sand content of the glacial debris has more or less disappeared and one has to wend his way over a veritable nightmare of boulders of all sizes arranged in a variety of shapes, cones, transverse ridges called "rehra", longitudinal ridges, platforms and so forth. These shapes are sometimes so regular that they appear to be made by some giants. They may be called

"Skeletal moraines." The sand and gravel in the river bed is fresh outwash material brought from the snout at Gaumukh. One extra-ordinary landform is the presence of clusters of giant boulder clay pillars about 100 metres tall, and capped by big boulders on top, which stand precariously clinging to the enclosing walls of the valley.

Another remarkable feature is a huge platform of boulders one kilometre wide, two kilometres long and 200 metres thick. It nearly chokes the valley near Chirbas. The snout of the glacier must have remained stationary here for some time to produce this end moraine of the past glacier. This feature is very common below many glacial snouts, such as at Vasudhara,<sup>7</sup> above Sheshnag in East Liddar valley,<sup>8</sup> and in Baspa valley.<sup>9</sup> The only difference in Bhagirathi valley is that here we have only boulders, but at other places the moraines are grassed. While in the Bhagirathi valley we have a very open U-shaped below Gaumukh, the U-shape of Yamuna near Yamunotri is very narrow. It continues to be narrower for six kilometres up to Janki Chatti, where looking up the valley, one notices a stage-like scene, with truncated spurs standing as side screens, the snowy Bandarpunch providing a back drop. A number of other such narrow U-shaped valleys join the main valley, till at Janki Chatti they open out. We may imagine a system of small glaciers in the past which gnawed into the steep slopes of Bandarpunch, from which water-falls cascade down into the valley today. Below Janki Chatti is a huge open bowl in the centre of which is situated Beef village. The feature is in all probability a giant cirque of the past. Similar features are found elsewhere in the Himalaya, such as at Mana and above Panchtarni.<sup>10</sup> Here a unique feature are huge platforms of glacial till, much bigger than those at Kedarnath,<sup>11</sup> or many other places.<sup>12</sup>

While morainic deposits of the giant glaciers have been greatly washed away in Bhagirathi valley, they fill up and choke the Yamuna valley upto Phul Chatti to-day. One

may conclude that the amount of glacial debris present to-day, in a high Himalayan valley is inversely proportional to the number and size of glaciers which feed the river to-day.

Bhagirathi valley has some other unique features. The river cuts a transverse gorge in granites of the central axis of the Himalaya, below Bha'ron Ghati. The gorge is very straight, as is expected by the sawing action of a glacier. The Y muna has, however, sawed through an exposure of quartzites lying at the bottom of the past giant glacier just beyond Phul Chatti. It has cut a steep rocky gorge through it. A tributary nearby has also cut a similar deep gorge in the quartzite. Near Gangnani in Bhagirathi valley and above Yamuna Chatti in Yamuna valley the glacial action of the past has produced rather similar features, U-shaped valley forms, giant truncated spurs forming tremendous rock cliffs and cascading water-falls of the hanging valleys. The only difference is that in Bhagirathi valley the V being cut at present in the U, is deeper than in the Yamuna valley. Therefore the Bhagirathi valley appears to be more closed near Gangnani than the Yamuna valley above Yamuna Chatti. Water-made features such as river terraces appear further down, (below Gangnani in Bhagirathi valley and Yamuna Chatti in Yamuna valley) and become a very common feature in both the valleys, and there is no contrast.

#### NOTES

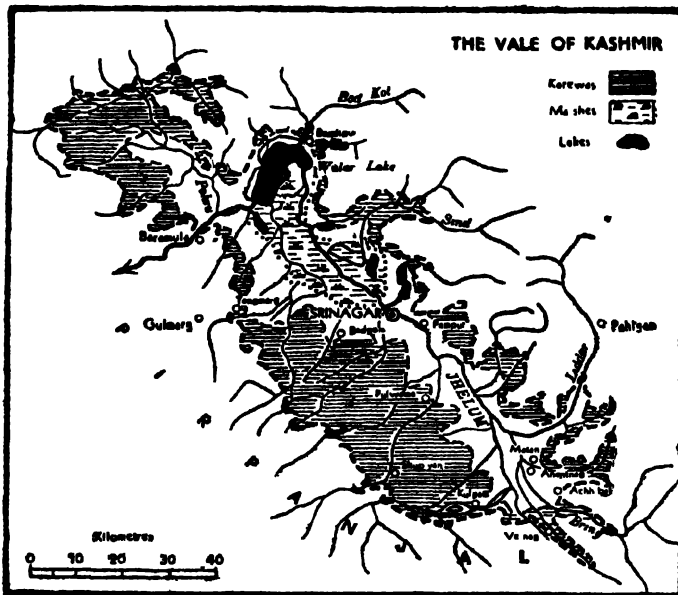
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## Lacustrine Basins

In a number places within the folds of ranges of the Himalaya are found flat basins formed by alluvial and glacial deposition. A study of these basins reveals that they are generally formed of ancient lake bottoms which have now been drained.

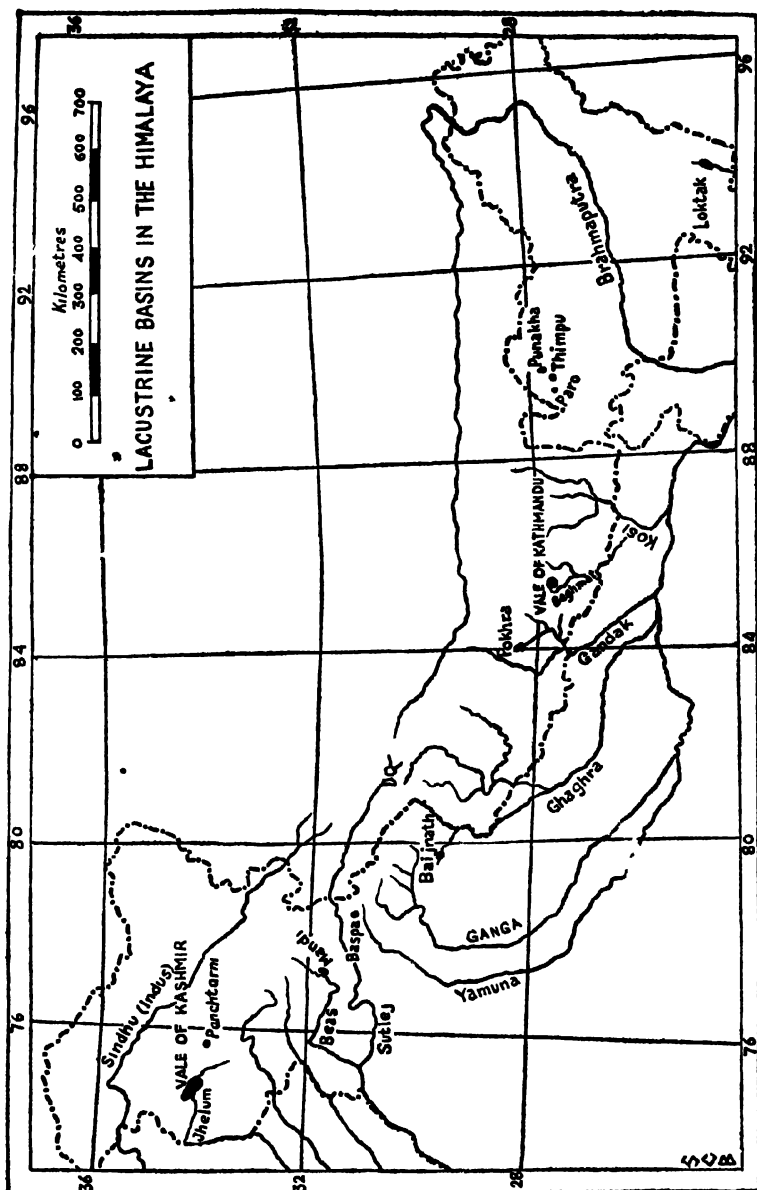
The most famous of such basins is the Vale of Kashmir, followed by the Vale of Kathmandu. The lakes were



Map 3

formed by the rise of middle Himalayan ranges such as Pir Panjal, Nag Tibba Range, Mahabharat Lekh and so forth, during the Pleistocene age. The ranges rose in a





Map 4

number of jerks. Large rivers like Sindhu, Sutlej, Ganga, Ghaghra, Gandak, Kosi and so forth continued to flow through by cutting them as they rose. They were antecedent to the rise of these ranges. But in some cases small rivers were obstructed by them and lakes formed in the valleys behind them. Ultimately the lakes over-flowed at the lowest lip, cut through the obstruction and drained out. The exposed lake bottoms form densely populated level lands today. Possibly these lakes disappeared and reappeared as the ranges rose in several jerks.

Lake bottom deposits are being eroded today by the present rivers.

**Vale of Kashmir :** This is an oval shaped flat valley by the enclosed Central Himalayan range and Pir Panjal. The longer axis of the valley is about 150 kilometres and the smaller one about 50 kilometres. The valley bottom has an altitude of about 1600 metres.

According to de Terra and P. Chardin Teilhard<sup>1</sup> there were four glacial periods during the Pleistocene. At the same time there were two or more uplifts of Pir Panjal range. This caused obstructions near Baramula, which in its turn caused the formation of lakes. During the lower Pleistocene, the lake formed has been called the Karewa Lake. Deposits in its bottom, now exposed, form Karewa beds which ring round the vale as one to two hundred metres high flat table lands. Today these beds are being eroded. After the formation of the first Karewa lake, it deepened and the enclosing ranges rose higher, from which fluvial, glacial and morainic materials slid into the lake bottom during Lower and Middle Pleistocene. The lake level fluctuated according to change in climate, rise of Pir Panjal and the erosion of the outlet near Baramula.

The total thickness of the Karewa is 2,200 metres. The deposition ended near the last phase of the first interglacial period, when the Karewa lake became dry. The lower Karewa beds deposited so far were eroded about

700 metres. As the second glacial phase set in the second Karewa lake was formed and deposition of upper Karewa beds started with an unconformity between the upper and lower beds. This second deposition continued during the second interglacial phase in Middle Pleistocene.

The Karewa beds were slightly involved in Himalayan orogeny. Their edges were upturned by the rise of Pir Panjal.

In the post-Karewa period the Pir Panjal rose nearly 2,000 metres, while the lake had disappeared. The lakes and marshes today have most probably been formed by a slight recent rise of the Pir Panjal.<sup>2</sup>

The eroded edges of the Karewa beds stand like scarps, and are deeply notched by gorges of streams descending down into the valley.

During the fourth glacial age, tongues of moraines spread over the Karewa beds. The meadow of Gulmarg is formed over one such moraine.

The Karewa of Maitand is viewed nicely from a temple on a pine covered hill spur. The Karewa of Tanmarg is also seen clearly from Gulmarg.

**Vale of Kathmandu :** This valley today is the heart of Nepal. It has a centrepetal pattern of drainage, the streams running from the enclosing walls of ranges into the centre to form the Baghmati, which washes the steps of the sacred temple of Pashupatinath and rushes through the deeply cut Chhobar gorge to drain out of the valley.

Here the Mahabharat Lekh rose to cut off Baghmati and produce a lake, in which again Karewa-like deposits formed. After cutting at Chhobar the lake drained out. Deposits similar to Karewas ring round the Vale of Kathmandu. Their appearance is very similar to the Karewa beds of Kashmir. Their edges form 100 metres high scarps. The landing ground of Gauchar is situated upon such a bed.

• Some layers of these beds are formed of sand, which behaves as an aquifer. Springs occur at places where the

sands outcrop. Stone mouths of dragons are constructed for spring waters to come out. Villages are located near the springs. The water is used for drinking and other domestic purposes. It is also used for irrigating paddy seedlings in the pre-monsoon period.

At places the beds are slightly folded and warped.

According to legend the Goddess Manjushri cut the Chhobar gorge by her sword and drained out the lake to produce the vale of Kathmandu, which she presented to the people of Nepal.

Tony Hagen<sup>1</sup> and H. L. Chhibber have both called the vale of Kathmandu as the exposed bottom of a lake.

**The vale of Pokhra :** This lacustrine basin is in Western Nepal. It has an oblong size, approximately 16 kilometres long and 8 kilometres wide. It was formed by the blocking of Seti Gandak river by the rising Mahabharat Lekh.

Today there are few remnant lakes in the basin, the largest being Phewa Tal, which is about 7 kilometres long and 2 kilometres wide.

Horizontal beds of conglomerates and marls occur in the valley extensively. Karst land forms are found in the valley in limy lacustrine beds, such as the Mahendra Gupha and other caves, fantastically deep and narrow gorges and subterranean passages in Seti Gandak.

Large glacial boulders of granite, gneiss and schist are found scattered and often embedded in the lacustrine deposits. As these beds are soft, the boulders are collected and dug out to provide material for fences, floors, walls and roofs. A huge boulder, which is worshipped is found at the northern end of Pokhra village.

The boulders were obviously brought to the past lake by glaciers descending from the adjoining mountains, specially from the great Annapurna range in the north.

The beds have been shaped into a number of river terraces by recent erosion, providing intermittent rise of the ground.

*Other lacustrine basins :* The vale of Manipur at the

eastern end of the ranges is also a lake bed in all probability. That it is a plain of deposition is revealed by its flatness. Loktak lake is obviously the remnant of the past lake. Near Mandi in the Beas valley there is a big flat piece of land which seems to be also of a similar nature. Yet another plain occurs around Baijnath in the Garur valley below Kosani in Almora district. Perhaps this is also a lacustrine basin.

There are a number of flat bottomed basins in Bhutan, which are also lacustrine basins. They have also been responsible for the location of the three leading towns of Bhutan, Paro, Thimpu and Punakha.

*Drained out glacial lake beds :* In some places in the Himalaya glacial lakes were formed in the past by moraine plugs formed by ancient terminal moraines. Some such lakes exist today, such as the Chhangu lake in Sikkim and Sesh Nag in Kashmir. At other places the lakes have drained out exposing the bottom. The best example of such a lacustrine basin is the upper Baspa valley beyond Simla. Here above and below village Sangla there are two such lacustrine basins.

In Kashmir in upper Sind valley, the plain of Panchtarni, used as the last camping ground on the pilgrimage to Amarnath is also the bottom of a drained out lake.

Lacustrine basins of a slightly different nature are drained out rock basins in the glaciated beds of rivers. A pair of such basins occur in the Bhagirathi valley at Dharali and Jhala.

## Climate and Weather Types

The great mountain wall spreading as a huge arc 2,500 kilometres long, north of the Indian sub-continent has climatic peculiarities of its own. The greatest cause of this fact is the physiography of this region. Himalaya and its adjoining ranges are the highest in the world. The average height of the central axis of this complex mountain system is nearly 5,000 metres, which means that it cuts through a major portion of the atmospheric air mass, considering the fact that denser layers of the air are at the bottom of the atmosphere. The great changes in altitude produce climates from tropical to arctic. The air currents often carrying moisture and clouds are much controlled by topography.

We may note low clouds passing across the valley and dropping down as evening approaches. Some of them escape over the enclosing ridges while others fail and roll back into the valley.

While it may be raining in the lower levels the sun may be shining on the snowy slopes higher up. Kalidasa has aptly described such a phenomenon, while writing about the Himalaya in the 'Kumarsambhava' the English rendering of which is given below : "After enjoying the cool shade under the clouds, round whose girdle, the saints, being troubled by rain, take refuge in the sun drenched high peaks above".

While sitting in the sun at Tungnath a peak 4,000 metres high lying between Chamoli and Ukhimath, one may note an electric thunder storm passing down below in the valley and white washing with fresh snow the higher ridges as it ascends above the valley.

The Himalaya wholly lies north of the tropic of cancer, and so it is in the north temperate zone on the globe. Yet the climate in its foothills to the south is tropical monsoon type.

*The Monsoon :* The creation of the Indian monsoon is also to a great extent controlled by the Himalaya, which helps in producing it and also in forcing the clouds to shed all their moisture on the southern slopes of the central axis. As the Himalaya cuts across the atmosphere it nearly separates the Indian air mass from the rest of the Asian air mass. This smaller air mass over India gets heated rapidly, very obviously, and produces the Sind Low, which is instrumental in producing the monsoon. As the monsoon current sweeps over India, it first strikes the upper Brahmaputra valley and produces heavy rain in the Assam Himalaya. It is nearly as heavy in the Bhutan foot hills and Darjeeling. Westwards the intensity of rain decreases. While Darjeeling gets about 250 centimetres of rain, Simla get about 150 cm. and Murree in Pakistan hardly 80 cm.

Rain also decreases northwards, till it is very little in the higher mountains. The cause is double. Firstly, every range running east-west cuts off moisture and secondly, moisture condensation occurs between 2,000 and 2,500 metres altitude. Higher up rain decreases rapidly.

The fact that the Himalaya effectively separates the Indian air mass from the Asian air mass also makes India hotter. So the foothills, though north of the Tropic enjoy tropical climate. The heat in the low valleys is excessive. In the west the climate also suffers from continentality. Summers are extremely hot, and the heat penetrates the valleys. Even Rampur about 80 kilometres north-east of Simla has a hot summer, while the snowy peaks of Dhaula Dhar are not far from it. The winters in the west are severe and snow falls generally even somewhat below 2,000 metres altitude.

As the latitude increase towards the west the winters

are colder, but the summers are hot due to continentality.

Humidity is excessive in the valley bottoms in the foot hills, especially in the east where the rainfall is high. Forest cover further tends to increase this humidity. In summer, with high temperature, the climate verges on muggy and uncomfortable. Above 2,000 metres the temperature falls and mugginess decreases. At times, however, the rainy days may be rather cold and damp. Above 3 000 metres the cold air cannot hold much moisture and absolute humidity decreases. It is cool and dry. The night skies are clear of dust. So quick radiation leads to cold nights.

During May and June the plains below the Himalaya to the south are very hot and dry with dusty hot winds and dust storms called 'loo' in the west and centre. The dust often rises high and reaches to a height of two to three thousand metres. It penetrates the mountain valleys and makes the sky grey even at night. The Kathmandu valley, 1,400 metres high has dusty skies at this time and the days are hot, while the nights are uncomfortably warm. Occasional showers bring relief. Katabatic or up-valley winds are sucked up during the day and they blow all the day furiously up the valleys up to 3,000 metres and more. As they reach the snowy peaks and ramparts near the central axis of the Himalaya they produce evening thunder storms. It is usual in May or June to have afternoon or evening thunder storms beyond Middle Himalaya. It is usual to see in the afternoon and early night distant electric thunder storms towards the snowy ranges from hill stations like Mussoorie, Ranikhet or Simla.

Aspect of a situation is also very important in Himalaya. Usually the southern slopes get more rain in summer and more sun in the winter which melts the snow.

This also reflects on the height of the snowline. There is more precepitation of snow on lower southern ranges,



and less and higher on northern ranges. Yet on any individual range the snow line is lower on the northern aspect.

Aspect makes micro-climates more important in the Himalaya, and so does altitude. In the valley of east-west running Bhagirath Kharak glacier the northern side of the valley toward Devdekhani is more sunny and has a temperate climate, while the southern side is frozen and has an arctic climate. A small field enclosed by 100 metre high lateral moraines above the junction of Bhagrinath Kharak and Satopanth Glaciers has a warm mild climate as the aspect is very sunny. Far away in Gilgit, one finds Hunza sunny and green, while in the shadow of the Rakaposhi mountain Nagar is cold and bleak. Beyond the central axis of the Himalaya the key note of climate is very low temperatures and low humidity. It is practically a cold desert. This type of climate is seen in Ladakh Lahul and Spiti. The average temperature of Leh in January is  $8.2^{\circ}\text{C}$ , and the average annual rainfall is 8.4 centimetres. A boy who was born in Ladakh and who stayed there till he had grown up had never seen rainfall. When he came to Almora as a grown up boy he became very much afraid of rainfall.

Wind direction and speed is much controlled by topography. The usual winds are up the valley in the day and down the valley at night. The speed is very great in high altitude. The phenomena of plumes over high peaks, such as on the Everest is due to very high winds.

In winter the northern winds are rather steady and stormy but they blow furiously through the passes from north to south. From October onwards this wind is very furious on Rohtang pass, and it blows strongly from midday to midnight. At times it is so strong that it throws down men and sheep.

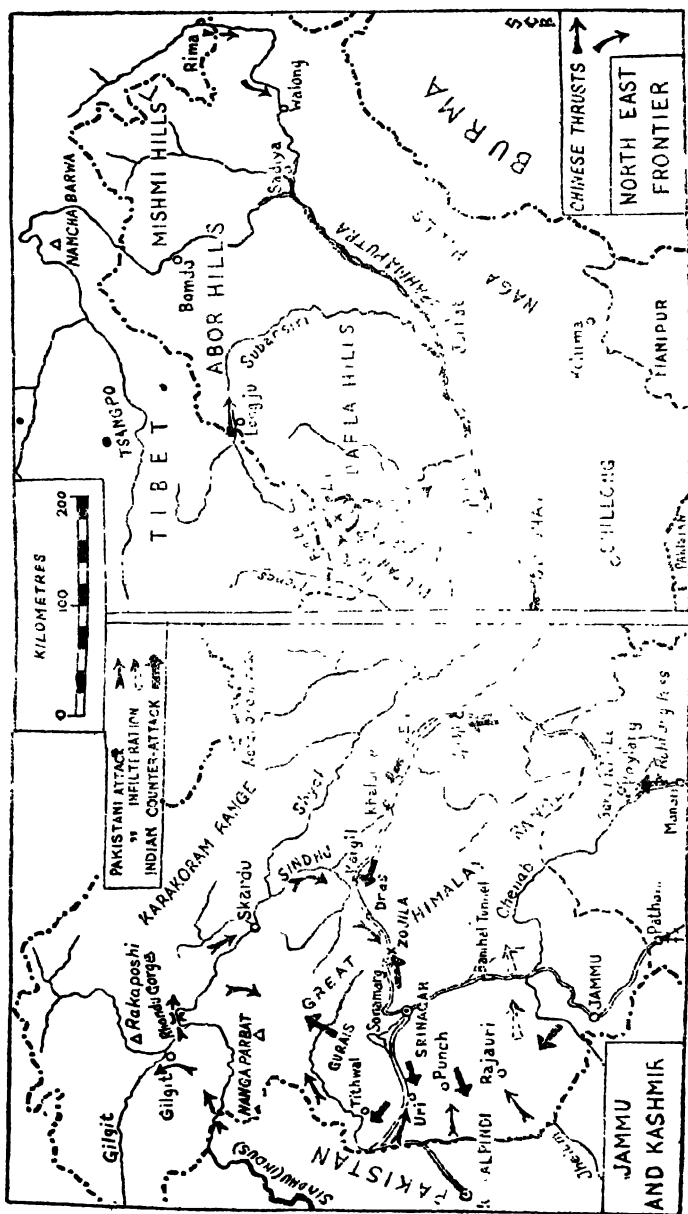
The above discussion reveals that aspect and altitude are two great controlling factors in the kaleidoscopic changes in climate and weather in the Himalaya.

## Terrain Evaluation

In the autumn of 1962 the Chinese succeeded in penetrating deep into our territory by their attacks at a number of places in N. E. F. A. The most spectacular advance of theirs was through the upper Manas valley. Here by a lightening thrust they captured Towang and surrounded, by a pincer movement, a large contingent of our forces at Se-La (Pass), and advanced further south to Bomdi La and beyond. We have to admit that they knew our mountain terrain much better than us. Yet as they advanced further to the foot hills, they realized that the terrain will be against them in the approaching winter, and so they withdrew their troops.

*Kashmir Operations :* A good knowledge of terrain once put the Pakistani forces on the run in Kashmir when they were on the point of surrounding the valley. They had come over from Baltistan and Skardu to the Dras Kargil road, captured both these places and advanced towards the Zoji La (Pass) above Sonamarg. In the south they had infiltrated into Punch-Rajauri area at many places, and at some points had gone across the Jammu-Banihal road, our life-line to the Vale of Kashmir. The situation was too bad for us. The Indian Army then sent a contingent at the back of Pakistanis near Kargil, by a new route through Manali, Rohtang Pass, Lahul, Bara Lacha-La and Leh. Our forces further succeeded in improving the road to Zoji La and mount a light tank attack on our enemy across this pass. And when they ran back they were attacked by the Leh contingent. They were out-manceuvred and had to flee towards Skardu.

Their demoralization was so complete that they started retreating on all the other Kashmir fronts.



**Map. 5**

Earlier our lack of the knowledge of terrain, prevented us from defending Baltistan at Rhondu gorge, through which the troops of Pakistan advanced without any hindrance. We did not take advantage of this easily defendable point.

The above examples show the great importance of a complete knowledge of terrain where army operations are conducted. A brief survey of the terrain in the three sectors of the Northern Indian borders is stated below.

### 1. Northern Sector

(a) *Ladakh* : The north-eastern half of the State of Jammu and Kashmir consists of a number of snowy-ranges fanning out from the Pamir Pivot towards the east and south-east. They are—

- (i) Aghil Range
- (ii) Karakoram Range
- (iii) Kailash Range
- (iv) Ladakh Range
- (v) Zaskar Range
- (vi) The Great Himalaya Range.

In southern Kashmir there are two more distinct snowy ranges. They are Pir Panjal and Dhaola Dhar.

In the west these ranges produce the world's most rugged terrain. In general the difference of level between valley bottoms and interfluvies is 5 to 7 thousand metres. At Bunji it is 8 thousand metres (between Nanga Parbat and Sindhu [Indus] gorge. The Karakoram is in some respects mightier than the Himalaya. Its breadth and general level is higher than any Himalayan range in India. From terrain point of view it is a negative area for any army movements.

(b) *Gilgit Valley* : To the west of Karakoram only Gilgit valley presents a milder topography. It lies at an average height of 1,600 metres, in the shadow of snowy pinnacles like Rakaposhi and Nanga Parbat. But the river Gilgit has developed broad terraces where the fields

and gardens of Gilgit spread out. To its north there is a narrow and dangerous route to Hunza, Trans-Karakoram and Pamir. It is at present occupied by Pakistan, though it is a part of Jammu and Kashmir State.

Kailash range stands south of Karakoram and extends into Tibet. Mighty glaciers such as Baltoro, Biafo and Siachen lie between the two ranges.

River Sindhu cuts a furrow through Kashmir and runs parallel to the Ladakh Range, sometimes north and sometimes south of it, cutting deep transverse gorges through it. Just near Chushul, our advance base in Ladakh, it cuts a gorge from north to south.

• Zaskar range extends south of the Sindhu and proceeds eastwards into Tibet beyond Manasarowar.

(c) *Great Himalayan range* : The great Himalayan Range does not go into Tibet, but enters Lahul from Kashmir and proceeds through Kinnaur into the northern districts of Uttar Kashi, Chamoli and Pithoragarh. From here it enters Nepal.

The first five ranges, Aghil, Karakorum, Kailash, Ladakh and Zaskar lose height as they go towards the west, meanwhile the general ground level rises. The difference between the valley bottoms and the interfluvies gradually decreases. The relief becomes mild. But the general altitude increases to about 5,000 metres. The tributary valleys of Shyok, Chip Chap, Galan and Changchenmo flatten out towards the west. It is a bleak rolling landscape, with no vegetational cover, consisting only of rock and ice. The low ranges and peaks are embossed upon it. Rainfall is nil. It only snows. The rocks have been pulverised by frost shattering, due to a large diurnal range of temperature. In the past this north eastern region of Ladakh was under the cover of a huge ice-sheet during the Pleistocene glacial epoch. The ice-sheet moved to-and-fro and acted like a gigantic sand paper. As it melted away it left huge quantities of glacial debris *insitu*, which completely disrupted the drainage of

the region. Numerous salt lakes were produced having internal basins. They are shallow and are often dry and salt encrusted. The shape of Pangong lake suggests that it was once a river valley tributary to Shyok. The salt encrusted plains have various names such as Aksai Chin, Lingtzitang, Soda plains, Depsang plains etc. There is practically no life in the region. Only groups of wild asses inhabit this area.

The topography being mild road building is comparatively easy. Air strips can also be constructed easily. But thin air rules out the use of ordinary aircraft. Only powerful aircraft can be used. Modern helicopters can also be used. Previously they could not climb so much.

Yet the aircraft require a longer run for becoming air borne and this means greater consumption of fuel.

The Chinese had to face their difficulties in Tibet, and their oil sources are far away and also meagre to continue a prolonged air war.

For the soldiers of India and China in Ladakh, the major difficulty was not topography but extremely low temperature and thin air. They must get acclimatized to such a hostile physical environment, before they can operate in Ladakh.

The contingent which was sent to Se La in N. E. F. A. was perhaps not acclimatised, and the soldiers probably suffered from altitude sickness.

In Ladakh our army is now fully acclimatised. The topography is favourable to China for supply and difficult for us. But this condition will be reversed if the Chinese advance southwards.

## 2. Central Sector

This sector spreads from Lahul and Spiti to Kinnaur and three districts of northern Uttar Pradesh. This in fact is not central Himalaya which lies in Nepal, but a part of Western Himalaya. The Great Himalaya runs very near the border, and the other ranges Zaskar and

Kailash are in Tibet. There are a number of comparatively easy passes near the border such as Shipki, Jelukhaga, Mana, Niti and Lipu Lekh. The Chinese and the Indian soldiers face each other at these points. Transport lines of the Chinese are easier and easy to develop and maintain.

On the Indian side topography is extremely rugged and building of roads and their maintenance is very difficult. There are small pieces of high plateau like regions north of the Himalayan axis, such as, the upper Jadh Ganga valley. Bara Hoti is a high altitude meadow on the border used by semi-nomadic mountain shepherds. They form glacis of India thrust into Chinese territory.

The portion of this border region in Uttar Pradesh is called Uttarakhand which has been famous for its holy shrines of Yamunotri, Gangotri, Kedarnath, Badrinath and others which are visited by thousands of pilgrims every year. As compared to other border areas Uttarakhand is well developed.

### 3. Eastern Sector

The terrain in this sector is different from the Ladakh sector in many respects. The lower portions of the mountains here receive heavy rain and are hence deeply forested. They are inhabited by a variety of tribes, who have lived here undisturbed by modern civilization until up to very recent times. The higher rainfall has led to greater erosion producing a wild and extremely rugged scenery.

In the upper portions the snow line is higher, and it is warmer than Ladakh. The great Himalaya range runs generally near the border. The lower ranges are less prominent.

*Chumbi Valley* : Between Sikkim and Bhutan the funnel shaped Chumbi valley lies south of the Great Himalaya, running between Kanchenjunga and Chomolhari. It belongs to the Chinese. This is the only glacis of the Chinese pointing towards India, and our border is

most vulnerable here. It consists of the Dongkya range, a sharp, frost shattered, knife-edged snowy ridge which is extremely difficult to cross. But over it there are a number of comparatively easy passes ranging from 4,500 to 5,500 metres, where the armies of India and China face each other. The Tista and its tributaries have cut deep canyons in Sikkim. Hardly 30 kilometres from Kanchanjunga the Tista goes down to one thousand metres only. The difference between valley bottoms and interfluves is higher than in the Western Himalaya.

*North East Frontier Agency* : In NEFA a number of rivers have cut across the Greater Himalaya crest and gone into Tibet. This has been possible by either head and water erosion and capture or by antecedence. These rivers are—

- (a) Manas and its head waters
- (b) Subansiri
- (c) Brahmaputra or Tsangpo
- (d) Lohit

The border runs all along the water shed except at the four points where these rivers cross the border. Bum La from where the major thrust of the Chinese came in 1962 is near the point where Manas crosses the frontier.

Longju is at the crossing of Subansiri. Here also a Chinese thrust developed.

There can be no threat through the Brahmaputra valley as it consists of, perhaps the World's most awesome gorge. Namcha Barwa rising to 8,500 metres stands at the great bend of the river which passes through a chasm 6,003 metres below. This gorge is impassable and is much more dangerous than the Bunji gorge of the Sindhu below Nanga Parbat.

The Lohit provides the easiest passage across the frontier near Rima. Here again the Chinese came up to Walong. The rich oil-fields of Assam are nearest to the Chinese from this point. The lowest ranges are deeply forested, rain soaked and rugged, Yet it is this point which should be strongly defended.



It will not be too much to say that though our northern borders are yielding to modern methods of warfare, waged with better weapons, better clothes and equipment and better transport including new roads, aircraft and landing strips, yet it is a great obstacle to enemies who want to advance across it into India.

The topography north of the border is generally mild and south of it rugged to the extreme. This puts a great strain on our force and quick lateral movement for us is extremely difficult, while it is easy for the other side.

Of course, the Chinese supply lines are long and the sources of supply are far away in the plains of Yangtze Kiang. The Indian supply lines are shorter.

Yet if the Chinese advance into India, their difficulties will rapidly increase, for they will have to enter the rugged terrain. So will be the case with Pakistan. Here it is necessary to point out that the question of our forces advancing into Chinese or Pakistani territories does not arise, as we are essentially a peace-loving nation.

## Environmental Control on Land-use

Perhaps the influence of environment on land-use is more pronounced where topographical changes are well marked. This will include rapid changes in land-forms, slope, degree of roughness of relief, changes in aspect, and variation in altitude. These physical factors also control the climate to a great extent. The altitude controls temperature. Gravitational air flow causes Katabetic movement of winds up and down the valleys. The aspect is responsible for precipitation and sunshine. All these factors control wind flow, formation of dew, fog, mist and frost. At higher altitudes fall of snow and sleet is also controlled by aspect. Rainfall and temperature, which vary from place to place in mountain environment, strongly influence land-use.

Environmental control is profound in the Himalaya. Here physical features change rapidly from place to place and micro-climates are of great importance.

*Alpine Pastures* : Above 5,000 metres, on the average, environmental control is supreme. It is a land of rock and ice. Some Alpine grass may grow in very secluded places, or where sunshine is prominent due to aspect. Here some grazing by sheep, goats, horses and cattle is possible.

Such high pastures are visited by semi-nomadic tribes with their animals during summers, such as Gujars of Kashmir, Gaddis of Kulu valley and Jadhs and Marchyas of Bhagirathi and Alakananda valleys. Man cannot improve or develop these grass-lands. They have a strictly limited grazing capacity. No woody forests can grow above 5,000 metres.

Between 4,000 to 5,000 metres there are more Alpine meadows. There has been considerable deforestation in oft frequented routes which lead to pilgrimage centres or passes. Birches, junipers and other high altitude oaks and pines can grow to provide timber and fire-wood. Milk, butter, cheese and meat could be produced in greater quantities and sent down to lower altitudes if modern preservation and packing facilities are provided. Co-operative collecting centres could be developed, where electricity could be used as power to produce dairy products.

*High Level Agriculture :* At such high altitudes between 3,000 to 4,000 metres only barley, buck wheat and other high altitude grains can be grown. Some varieties of wheat are grown and new quick growing varieties could be introduced. "Phabar" a kind of barley is grown around Mana. Fluvioglacial terraces, stabilized talus cones and centres of glacial amphitheatres provide land for cultivation. This type of cultivation is only done by semi-nomadic people usually of Bhot or Bhotia type around the permanent high level villages, such as Mana, Niti, Nilang, Chitkul etc., and also in Ladakh, Sikkim and Bhutan. Barley is the leading cereal which when roasted provides food (Sampa), and drink when fermented. Barley grows more or less in lower altitudes also, as in the Kulu valley above Manali, around Joshimath in Alakananda valley, in Dhauli Ganga and Mandakini valleys.

*Coniferous forests :* Between 2,500 to 3,500 metres the slopes are generally very steep. The valleys are closed by sheer cliffs and truncated spurs. Higher up over the shoulders of the valleys it is too cold for cultivation. The steep slopes also do not give sites for crop production. So the most important land use is forestry. However, little attempts have been made to regenerate forests, though these efforts are now increasing. *Pinus longifolia* and *roxi*burga grow very easily and are even replacing *Quercus Incana* and *Dilatata*. They make soils acidic and fit only for potato and barley in places where the degree of slope

is gentle. Pines are an important source of resin and soft wood.

*Potatoes* : Potato is a leading vegetable in the Himalaya. It is produced abundantly in and around the Vale of Kashmir, around Manali in Kulu valley and the district of Chamba, in Simla and Garhwal, and in Sikkim and Darjeeling. Khati is a potato growing village on the route to Pindari glacier. Potatoes find an important place in export to the plains. Seeds are exported in autumn.

*Fruits* : Temperate fruits, specially apples, grow well in many favourable situations at this altitude. Kashmir and Kulu are famous for their apple gardens. While the orchards belong to local people in Kashmir, they are owned by a selected few in Kulu. Major Banon, an English settler in Manali and his progeny have much to their credit for developing apple orchards. Another English settler grew apples in Harshil in the Bhagirathi valley at height of 2,500 metres. Local people have now developed apple orchards here.

The Uttar Pradesh Government has done much to develop apple and other fruit orchards in Nainital and Almora districts. The gardens of Ramgarh, Chaubatia and the citrus research station at Hawalbagh may be mentioned in this respect. Land use pattern is dominated by fruit orchards in Ramgarh. Apple growing is also increasing in Sutlej valley near Simla around Kotgarh and in the Ravi valley in Chamba. Apples of Sikkim are also well-known.

Other temperate fruits grown are pears ( Baggugosha ) and peaches. In slightly warmer situations apricots and plums are grown. Cherries, raspberries, etc. are also being produced, specially in the hills of Uttar Pradesh and Himachal Pradesh, where fruit belts are in the making.

Now-a-days very little fruit is grown in this belt in Tehri and Garhwal, where thousands of pilgrims to Badrinath, Kedarnath, Gangotri and Yamunotri will eagerly buy them if available. Fruits are grown only at a

few spots by some chance. Wild apricots grow in many places, but are often not marketed. There are a few peach gardens. Often a rich landlord grows fruits for his own consumption. Special attention should be given to growing grapes, which are developed in some quantity only in Kashmir. They are also grown in Kinnaur, where grape wine is made. Oranges are very important in warm valleys of Eastern Himalaya in Darjeeling and Sikkim. In Nepal Pokhara valley has been called the valley of oranges. Himalayan oranges are very sweet and juicy.

It may be said with confidence that fruit production in the Himalaya could be increased ten times with a slight effort, and perhaps hundred times with more effort. Himalaya can easily become a great supplier of fruits.

*Nuts* : Another very important group of commodities of Himalayan gardens are nuts of many varieties such as almonds, walnuts, chilghoza and pistaccio. They have been developed to some extent in Kashmir, where better varieties such as "Kaghzi" almonds and walnuts have been produced. They have slowly spread from Kashmir to Kulu and Simla Hills. Chilghozas grow abundantly in Kinnaur. It is strange to note that though walnuts grow wild in Suki on the route to Gangotri, the local people do not even know that they are edible.

*Vegetables* : This is another group of commodities which are little developed in the Himalaya and have immense possibilities of expansion. The most developed vegetable growing areas are found in Darjeeling Hills. Here cauliflowers, cabbages, beans, peas and many other vegetables are grown and exported, often by air, to the Calcutta market. At the other end in Kashmir the demand to supply vegetables to a great number of tourists has resulted in a unique "land-use", where vegetables are grown in floating gardens on the Dal Lake. Water-chestnuts are grown in Wular lake and in Loktak lake in Manipur at the other end.

Vegetables are grown in Simla Hills to supply the

needs of a good number of Hill towns and Cantonments such as Simla, Solon, Dharampur and Kasauli. Similarly they are grown in the "Lake-land" of Kumaon to supply to the markets of Nainital, Ranikhet and Almora. Here vegetables are being increasingly grown in the Kosi valley. Some vegetables from these places are sent down to the plains in summer.

However, it is easy to understand that even a "Vegetable belt" could be developed all along the mountain at an altitude of about 1,500 to 2,500 metres to supply cabbages, cauli-flowers, peas, beans, squashes, turnips and so forth to the plains towns during summer. Some effort is being made in this direction. Squashes grow wild in Darjeeling Hills, and their export could be increased easily to the Calcutta market. Peas, beans and cabbages are being increasingly exported.

*Tea* : In the hills and ranges surrounding Darjeeling and Kurseong the land-use has been transformed completely by man by covering vast slopes of land by tea-bushes. Environmental control limits the tea gardens between 1,000 and 2,500 metres. The best quality tea with the finest aroma is found at the high level limit. The optimum development is at an altitude of 1,500 metres. Darjeeling tea gardens give lesser profit inspite of the good quality of tea, as labour is costly. Some tea gardens are found in Almora and Kangra. But though environment for growing good tea is abundant, economic factors limit further expansion.

*Saffron* : This consists of a very special type of scented flower petel, which is used for flavouring and colouring food. Saffron is grown in very limited areas only in Kashmir in Pampur near Srinagar and Kishtwar. To pick and cure the flower petels, requires special skill. Saffron is very costly and is in great demand. With some effort perhaps more saffron could be grown in other parts of Himalaya, where the environment is similar to Pampur. Kashmiri saffron growers could help in this matter.

*Cereals* : Cereal production, at best, aims at self-sufficiency in the Himalaya, where it cannot easily develop surplus production, which is more or less ruled out by lack of gentle slope.

In the middle levels between 1,000 and 2,000 metres the cereals are grown according to slope, soil type, water supply and aspect. Paddy and wheat are grown on the best type of land, and sometimes even both these crops are grown in the same field in summer and winter. Valley bottoms and river terraces are chosen for growing paddy, where the supply of water is adequate. On gentle sloping sides of valleys where level terraces can be made and water supplied from springs paddy is grown in summer. Paddy is the leading foodgrain in the vale of Kashmir. Paddy is also more important in Eastern Himalaya.

Wheat is often grown in paddy fields in winter. A kind of spring wheat is grown in higher levels. It is sown in autumn, when the fields are covered by snow in the winter. In spring, as the snow melts, the seed sprouts. It is harvested in early summer. Such a practice is noted in upper Sarju valley above Begeshwar. Wheat is rarely grown in Eastern Himalaya.

A very important cereal in the Himalaya is maize. It may well be the leading cereal of the hills. Maize needs a cool, damp climate. It does not need much heat. Its water requirements are not so much exacting as those of paddy. It may also grow in some raised situations, and gentle slopes, where the terraces may not be perfectly level.

Maize is a very important cereal in the vale of Kashmir. It grows, there where paddy does not grow. The crop is tall and healthy. The yield is fairly high. In the surrounding hill slopes maize is mostly grown. Maize is a favourite cereal in Kulu and Chamba. Its orange cobs, left for drying on slate roofs of village huts, give colour to the scene. It is a leading crop in Simla Hills, in Punjab and Uttarakhand in Uttar Pradesh. It is also fairly important in the Ram Ganga and Kosi valleys in

Nainital and Almora districts. In Nepal, Darjeeling and Sikkim maize is an important crop.

In western Himalaya a variety of millets are also grown. Madua is quite common in the Sarju valley and the Kali and Dhauli valleys of Pithoragarh. A kind of millet with a red tuft called Chua grows in a fairly wide range from Kulu valley to Alakananda valley.

Cereals are grown in valley bottoms, river terraces, gentle stabilized talus cones and man-made terraced slopes. Environmental control is evident in the degree of slope, altitude and water supply conditions. Hills of Ranikhet and Almora are heavily terraced for growing paddy and maize. Yet the scope for expanding the output is limited.

*Semi-tropical forests* : Below 1,000 metres agriculture again becomes unimportant and dense tropical to Semi-tropical forests prevail. They are warm and unhealthy, and are utilised only as sources of timber. Agriculture is found only in small clearings, where slope is gentle. Here maize, paddy or millets are grown.

From the above facts we witness a great variety in the pattern of land-use. Alpine pastures in snowy surroundings, dense forests of conifers and oaks, fruit orchards and terraced fields. They give various kinds of products of which are marketed in the plains.

The immense resources of the Himalaya are not yet fully tapped.



## Development of Transportation

Mountainous regions have always stood against the development of transportation. The more rugged the terrain, the more difficult it is to build transport routes and maintain them. Little wonder that Himalaya, being the mightiest mountain of the world has remained very poorly developed in transportation for a very long time indeed.

Before independence there was no motorable road across the Himalaya. The first such road, which was jeepable, was constructed up to Nathu-La on the north-eastern border of Sikkim. The Chinese built a motor road up to the Chumbi valley to Nathu-La, thus completing the first motor road across the Himalaya.

The Chinese built road through north-western Ladakh and the Indian road to Leh and beyond to Chushul may be taken as the next road built across the Himalaya. The Chinese built new Kathmandu-Kodari road and the Tribhuvan Rajpath from the plains to Kathmandu which constitute the third and perhaps the best motor road across the Himalaya. There are only three small Hill railways in the Himalaya to Darjeeling, Simla and to Jogindernagar in Beas valley. There are two well developed aerodromes in the Himalaya, in Kathmandu and Srinagar and a few other landing strips, military landing grounds and helipads.

Various factors have contributed to the rather phenomenal development of transportation in the Himalaya during the last three decades, the most important reason being the rising strategic importance of our northern borders.

Remote places are now linked by a network of fine

motorable roads. The ever advancing road heads have proved a boon to stagnant mountain regions and have been instrumental in stimulating and vitalizing their economy. Horticultural activities have increased by leaps and bounds in places where roads are advancing. Traders from the plains now flock to the mountains to purchase goods from the hill people.

More and more roads are being built in the Himalaya for strategic as well as non-strategic purposes. Modern methods of transportation are also slowly coming into vogue.

Sky-line logging has been introduced. Ropeways have been and are being constructed. Large tunnels piercing snowy ranges are also coming up. Transportation can be further modernized by using electric traction, taking power from hydle plants.

There has been a phenomenal development of motorable roads in the recent past, mainly due to strategic reasons. Even during the Second World War, the British very quickly built a number of very important roads across our northern and eastern borders. The fear of the invasion of India by the Japanese and later the advance of the Allies into Burma and beyond was responsible for the building of the famous Burma Road linking the rail head at Ledo in Brahmaputra valley with the upper Chindwin valley across the Patkai Ranges. The road further went to Myitkyina rail head in Burma and the river port of Bhamo on the Irrawaddy. It then passed on into China to Kun-Ming after climbing steep water-sheds and descending into deep gorges of Salween, Mekong and Yang-tze-kiang. However this road has gone into decay for it has little civilian use, as it passes through inhospitable, rugged and deeply forested country in many of its portion.

Another motor road from Dimapur railway station, ascends to Kohima and passes through Imphal, to the border at Moreh. It crosses over into Burma at Tamu

and proceeds to Kalewa and Mandalay, an important city in central Burma. It has a greater commercial importance than the Burma Road. Imphal is a good strategic point in the Manipur basin. Imphal is joined by a new road to Silchar, through which a new metalled National Highway passes from Gauhati, Shillong and Jowai to Agartala. All these roads have great strategic importance. Imphal has an air landing strip, and is connected by regular air services to Calcutta and a few more places in Assam and Tripura.

Road building in the *North East Frontier Agency* has been rapid in the last decade. This region was practically no man's land during the British regime. But with the mounting threat from the Chinese and due to the invasion they made in 1962, much is being done to improve transportation in this wild mountainous region inhabited by hill tribes.

A road has been built up to Walong in Lohit valley and is being further extended towards the border near Rima. Roads have also been built in Subansiri valley. The best known road is from Tezpur to Bomdi-La, extending beyond towards Se-La and Towang.

The roads in NEFA are bound to develop this remote region in time. They will also provide cultural contact between the tribes and people from the plains. NEFA has few economic products at present for export to the plains. It is inhabited by people who are absolutely ignorant of money exchange economy, and so NEFA will be slow in developing and taking advantage of the new roads.

Many landing grounds, landing strips and helipads have been constructed for military purposes. In time they will prove useful for civilians.

The mountain kingdom of Bhutan had no roads in the past. But Indians have recently constructed a link motor road starting from Phuntsoling on the border and climbing to a place named "Confluence", where it bifurcates and reaches Thimpu the capital and Paro. Before the construction of this road Paro was reached by a mule track

from Nathu-La or Jelep-La through Chumbi valley in Tibet. Bhutan was remote and difficult to reach. Today trade is increasing along the new road. Further road development in Bhutan is sure to follow bringing cultural contacts and economic uplift of the country.

Roads are developing fast in Sikkim and Darjeeling. The only mountain light railway, a marvel of engineering with its loops and zigzags, in eastern Himalaya ascends up from New Jalpaiguri to Darjeeling via Kurseong, Sonada and Ghoom. With it ascends a motor road which proceeds further to Leborg and then descends as a jeep road to Manjhitar in the Rangit valley, which flows along the border of Darjeeling and Sikkim. The road then proceeds to Tista bridge road junction. From here another road ascends to Ghoom on the Darjeeling road. Yet another jeep roads ascends from Tista Bridge to Mangpu cinchona plantation, where useful trees and herbs are also being grown, such as Tung tree, which yields a resin for varnishing and ipecac. The main metalled road from Siliguri to Gangtok passes through Tista bridge. From here again a beautiful road goes upto Kalimpong, an old wool collection centre, which came from Tibet via Jelep-La. There are stocking, grading and baling arrangements of wool in Kalimpong. An old mountain railway track for some distance upto Geillekhola along the Siliguri-Tista road has been abolished. A rop way connects Kalimpong to a point down below in the Tista valley. The road at Kalimpong ascends further up and extends as a jeep road to Jelep-La. Trade on this route flourished in the past, but has now decreased due to tension with China. It is now important for military purposes.

Ghoom is another important road junction. Through it passes the Siliguri-Darjeeling road, and it is also joined to Tiger Hill, Mongpu and Tista Bridge. Towards the west a metalled road proceeds from Ghoom along the Ghoom ridge to the market place of Sukia Pokhri and then on to Simana Basti on the Nepal border. Here it will

ultimately connect with the east-west Nepal Highway being slowly constructed. A jeep road from Simana Basti extends northwards along the border to Manibhanjang. Tonglu and Sandakphu, ascending to nearly 4,000 metres. Sandakphu is visited by tourists for viewing Kanchunjan-gha and Everest groups of peaks. There is a roadway for Darjeeling to Pull Bazar.

All these roads in Darjeeling are highly important commercially. They carry tea, timber, potatoes and potato seeds, vegetables, fruits, dairy products, cinchona bark and so forth. They are also used by an ever increasing number of tourists.

The Tista valley road joins the National Highway to Assam at Sevoke. It ascends upto Gangtok, the capital of Sikkim. It carries all the trade to Sikkim. From Gangtok there is a road and ropeway towards Nathu La. It has a great strategic importance. A new road called North Sikkim Highway has been built up the Tista valley to Lachung beyond the central Himalayan axis. It passes through Singhik and Mangan.

The Himalaya in Nepal remained conspicuous for its lack of roads for a very long time. Motor cars were carried on men's shoulders along a mule track from Raxaul to Kathmandu. A new road has now been built from Raxaul via Birganj and Bhainsi to Kathmandu. It is called Tribhuvan Rajpath. The Kathmandu-Kodari road built up by the Chinese joins with Lhasa. Thus it goes right across Nepal Himalaya. From Kathmandu roads go out in all direction like the spokes of a wheel to Patan, Sundari Jal, Trisuli project, Chhobar, Dakshin Kali and so forth. The vale of Kathmandu is no more an isolated valley, with a few cars belonging to the king. Modern buses ply in all direction from Kathmandu today, and there is fleet of cars, taxis and jeeps. Heavy trucks ply on the Tribhuvan Rajpath carrying heavy traffic. There has been much commercial development after the building of the roads.

A leading eastwest highway is also under construction through the country. It will join Ilam, Dhankuta, Ramechhap, Kathmandu, Trisuli, Gorkha, Pokhara and Dang. A road has been nearly completed joining Sunaoli on the Indian border to Bhairawa, Butwal, Tanseng and Pokhara. Sunaoli is joined by road to Gorakhpur and to Nautanwa railway head. Roads are developing fast in Nepal. A new road has also been built from Koilabasa to Dang. It is joined to the rail-head at Jarwa.

Kathmandu is a well developed aerodrome. It is joined by regular air-services to the cities of India and Pakistan. It is also joined to landing strips at Pokhr, Bhairawa and Birganj. Nepal has its own civil airlines.

In Uttarkhand division in the three newly constructed districts, Pithaura Garh, Chamoli and Uttar Kashi of Uttar Pradesh, there has been a phenomenal development of roads, which have today assumed the shape of a net work. They are strategic as well as non-strategic. They have helped in the fast developing economy of this region.

The eastern most of these roads is a new beautiful road from Tanakpur rail head towards Lipu Lekh Pass near the border, over which passes the route to Manasarovar. It has a great strategic importance. It passes nearly along the western border of Nepal joining with Champawet, Pithaura Garh, Askot and Garbyang. It follows the Kali-Sarda valley. A number of roads bifurcate from it. A small branch goes from Lohaghat to Mayawati Ashram. Another road goes from Ghat to Almora, via Jageshwar. Yet another road joins Askot via Thal with Bageshwar, which is again joined to Almora via Kosani and Baijnath. From Kathgodam rail-head start roads to the Lake Land of India around Naini Tal—a great tourist resort. The main road goes via Bhowali and Khairna to Ranikhet and Almora. There is a short cut road between Khairna and Almora. From Nainital there are roads to Ramgarh, Paharpani, Mukteshwar Bhimtal, Naukuchia Tal etc. Bhimtal is again linked by a short cut to Kathgodam. A

new road to Nainital Tal is being constructed from Khurpa Tal side from Kaladunghi. From another rail head at Ramnagar Mandi a road goes to Ranikhet via Tarikhet. This road is again linked to Karna Prayag. As previously indicated Almora is a big road junction, and from it goes a road northwards to Kosani, Baijnath, Gwaldam and on to Karna Prayag.

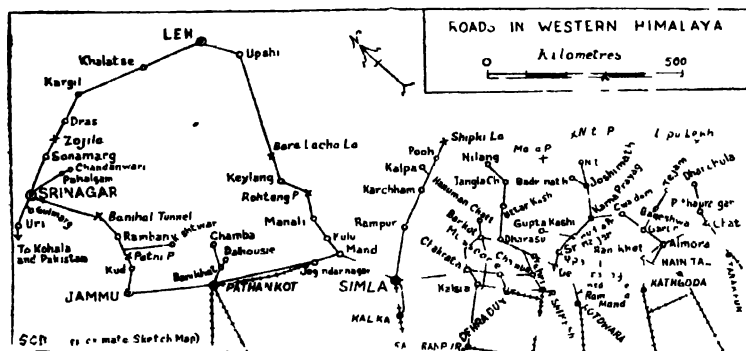
From Rishikesh rail head start two famous mountain roads, one to Badrinath and the other to Bhagirathi valley and Nilang. Both these roads are strategically very important as they provide means to defend Niti, Mana, Jelukhaga and many other passes. They further serve thousands of pilgrims to Badrinath, Kedarnath, Gangotri and Yamunotri. Further all these roads have provided much economic stimulation.

The British, during the Second World War, hurriedly built up a road to Chamoli. The Indian Government was very slow in further extending the road and it took nearly five years to built only 16 kilometres upto Pipalkothi. Progress has been rapid in the last two decades and the road has now gone upto Badrinath, with a jeep road extending upto Mana and beyond in the glaciated Saraswati valley. Another road bifurcates at Joshimath to reach Niti pass. From Rudra Prayag yet another road goes towards Kedarnath upto near Gupta Kashi. The rest is a mule track. Many branch road have been constructed joining with the Trunk road.

There is a good air-strip at Ganchar which is not in full use at present. However, it can be developed as a good landing ground for civilian air traffic.

The second trunk road from Rishikesh has been built up the Bhagirathi valley towards Gangotri upto Jangla from where it ascends up the Jadh Ganga valley to Nilang. From Jangla a mule track goes upto Gangotri and is being extended upto Gaumukh. From Rishikesh the road ascends to Narendra Nagar and goes wriggling up and down ridges and valleys, till it reaches the great terraces

above Tehri, which is joined by a link road to Dev Prayag on the Badrinath road. Further the road extends to Dharasu where the terraces are very well developed and shall easily provide for an air-landing strip. Dharasu is again connected by a link road to Barkot on the Yamuna, where a new Yamuna valley road comes from Kalsi, and is being extended beyond Barkot upto Hanuman Chatti on the way to Yamunotri. It is a non-strategic road, but it has already proved a boon to the people of the valley, where potatoes, apples and other fruits and nuts are being increasingly grown for export. Above Dharasu the Bhagirathi road passes through Uttar Kashi, Bhatwari and Harshil to Jangla. Cabbages and beaps are also grown. The road will help in the developments all these and more varieties together with potatoes. Barkot has again developed as an important road junction. From here a road crosses Yamuna to Jaunsar-Bawar and on to Chakrata. Another link road connects Chamba on the Bhagirathi road a few kilometres before Tahri to Mussoorie.



Map 6

This road extends to Chakrata, from where a new road is being completed up to Simla. The Badrinath road is connected to Bageshwar from Karna Prayag via Gwaldam and Baijnath. But Srinagar below Karna Prayag is a big road junction and it is joined via Pauri to Kotdwara rail head. It may be noted that Simla is joined by a road to Mandi in



the Kulu valley, from where the road goes via Manali and Lahul to Leh and Srinagar. Thus a lateral road through the Himalaya may be considered as complete. One may travel from Dharchula near the Nepal border by motor roads to Srinagar in Kashmir by Dharchula-Pithaura Garh-Ghat-Almora-Baijnath-Gwaldam-Karna Prayag-Srinagar (Garhwal)-Dev Prayag-Tehri-Chamba (Garhwal)-Mussoorie-Chakrata-Simla-Mandi-Keylang-Leh-Kargil-Sonamarg-Srinagar.

There is a net work of roads in Uttarakhand. Economic development is, however, slow. Perhaps the hill people go with old standards of self-sufficiency economy.

A new hydle project is under construction in the Tons valley, a tributary of Yamuna. A road for this purpose has been built from Dakpathar barrage on the Yamuna to Koti. Dakpathar is joined by a road to Dehradun rail-head, from where a fine road ascends upto Mussoorie. Road building has progressed much in Himachal Pradesh. Here again there are a number of good motor highways. The most important of these is the National Highway to Tibet from Simla to Shipki-La. The road at first goes on a high level from Simla to Kufri, Matyana and Narkanda. It then drops to Ramgarh in the Sutlej valley, and then ascends to Chaura, Tapri, Karchham and Pooh reaching Shipki-La on the border. At many places this road is grooved through vertical rock faces. It is a marvel of engineering.

Simla is joined to Kalka by a hill railway and a fine road. There are many branch roads from this road to Kasauli, Sabathu and Chail. Simla is a great road junction with roads to Mandi via Tattapani, Nahan and Chakrata as already indicated.

A branch road is being built from Karchham to Baspa valley. There has been much development of tourism and trade in the Sutlej by the construction of these roads. The best example of economic development are the extensive fruit orchards around Kotgarh.

The other truck road of Himachal Pradesh is from Pathankot to Kulu valley via Kangra, Baijnath and Mandi. It proceeds to Katrain, Manali, Rohtang Pass, Keylang and Bara Lacha-La. It then enters Kashmir to reach Leh in Ladakh. Another road from Pathankot goes to Dalhousie, and from Banikhet, ten kilometres below Dalhousie, a road goes to Chamba and beyond towards Bara Bangahal. The Manali—Keylang-Leh road has a great strategic importance. The Pakistani army which had infiltrated to Kargil, were attacked by the Indian army from their back by the use of this road. The road has also a great importance economically. It is essential for the development of tourist trade and apple orchards in Kulu.

An airstrip near Kulu operates during the tourist season and it has become popular.

In Kashmir the development of roads has been influenced by the creation of Pakistan and later the invasion of Kashmir by the Pakistani troops. The present roads of Kashmir have a great strategic importance.

The main road to Srinagar in undivided India was from Rawalpindi to Muree and Kohala and then along the Jhelum valley to Domel, Uri, Baramula and Srinagar. But today the cease-fire line crosses this road at Uri, the west of which road is under Pakistani control now. It can be easily imagined that in the present circumstances this fine road has gone to the control of military thus it has very little economic value.

The Government of India had to develop the second main road from Jammu to Srinagar. The rail link to Sialkot was removed upto the border, and a new road was built from Pathankot to Jammu. The road was broadened and much improved. Pir Panjal range was pierced 700 metres below Banihal Pass so as to avoid snowing up, by a pair of tunnels named after Jawahar Lal Nehru. There are some branch roads from it. One of these goes to Bhadarwah and Kishtwar. A branch from Khanabal goes

to Pahalgam and Chandanwari, which extends as a mule path to Amarnath cave over the 3,800 metres high Mahangu Pass. It also joins with Baltal below Zoji-La on the Leh-Srinagar Road. Another mule track goes to Kolahoi glacier. But the most important road built is the Srinagar-Leh road through Sonamarg. Baltal, Zoji-La, Dras, Kargil and Khalatse. Many more branch roads and jeep roads have been built in Kashmir for strategic purposes such as the Jammu-Punch Road.

The phenomenal development of roads in the Himalaya in the past two decades are treated here. Remote places are being linked by roads. Pilgrims to the shrine of Badrinath have not walk for long distances on dangerous tracks. There has occurred a great stimulation of economy of the hill people. Though many of the roads have been built for strategic purpose, they have proved very useful to tourists, hikers and mountaineers. Cultural contacts have increased due to these roads and even the little known community and the semi-nomadic people of the high Himalaya are slowly changing their habits owing to this contacts. They have learnt to use torches, cigarette lighters and even transistors.

There is some air traffic, but it should be further developed. Ropeways and sky-line logging are gradually coming into vogue. Further development of this type of transport is necessary in the mountains.

Electric traction should also be developed by building hydel plants for power. There is none of it today, while it is so frequent in other mountaneous countries like, Switzerland, Italy and Japan.



## **II**

# **THE PEOPLE AND THEIR SURROUNDINGS**



## The People and their Varieties

There are multitudinous kinds of people inhabiting the Himalaya, which includes unsophisticated peace loving folk of the valley bottoms and lacustrine basins, the semi-nomadic tribes and even ferocious head-hunters. Just as altitude and aspect have a great importance in the climate and weather types and environmental control is profound in land use, it has a great influence in producing a great variety of the people in the Himalaya. The high mountain ranges have acted as cultural barriers. They have hindered the movement of the people and their culture. So its development has occurred in pockets. The culture of the teeming millions of the great plains of India has slowly spread into the lower Himalaya, but that of high secluded valley is nearly at a standstill. High snowy ranges have fostered seclusion and have been prohibitive in the fusion of cultures. While the culture of the plains of Punjab in the form of language and dress has remained south of the Pir Panjal range, the quaint Kashmiri culture is found in the vale of Kashmir. The keynote of such a phenomena is isolation. Similarly we find a great culture change as we move from the south of Dhaola Dhar to the north through the wild Lariji gorge, where the semi-nomadic Gaddis live.

However, a number of dominating cultural flows can be recognized. The two main currents are the Buddhist Lamaistic Tibetan culture from the north and the Hindu culture from the plains of India. A third inflow of culture is the Muslim Persian influence from the west which is dominant in Kashmir, and has more or less spread up to Kinnaur, the Sindhu-Ganga water-shed providing a cultural divide.

The Kashmiris, the Chambials, the Gaddis and the Kinnaurs, have aquiline noses, fair complexion and tall stature. They grow and eat fruit, curd, *panir* (cheese) and meat. On the east of the divide the Garhwalis and the Nepalese have round faces and snub-noses, and are short statured in general. They do not grow or eat temperate fruit.

One of the finest examples of intermixture of culture is provided by the prevalence of polygamy and polyandry. While polygamy is practised by Muslims, polyandry is common in Tibet. The Muslims of Gilgit are polygamous, while the people of Ladakh who practice Lamaism are polyandrous. The Baltis of Baltistan lying between Gilgit and Ladakh are monogamous. There are many varieties of polyandry in high regions of the Himalaya. In Lahul the society is matriarchal. A woman may have a large number of husbands, who work for her. In the great Dassehra fair at Kulu in autumn groups of gaily dressed Lahuli women come for fun and frolic, but few Lahuli men visit the fair. One or two may come with the groups of women as guards and workers.

In Jaunsar-Bawar there are polyandrous Hindus. It is the result of strange inter-mixture of culture. Here all the brothers of a family have one wife. The custom may be compared to the legend of Mahabharata where the five Pandawa brothers had one wife, Draupadi. The economic factor behind this custom is that it protects property from division. They practise natural control of birth.

In eastern Himalaya many tribal people of the hill have amatriarchal society. The Manipuris who practice Vaishnavism are matriarchal. Usually men do not work. Their only duty seem to marry a Manipuri girl. Women with children on their back and marketable commodities on their head are often seen wandering their way to the market of Imphal every morning, where they sit for the whole day to sell their ware. A special product of Manipur is handloom-textiles, all woven by women. The yarn now comes by



air from mills in the plains from Bombay and Ahmedabad. Throughout the eastern Himalaya it is 'a must' for women to know how to spin and weave. The Manipuris are artistic people. The songs, dances and dramas of Manipur are famous.

Near by the Loktak lake a strange Manipuri community, perhaps unique in India, lives on floating houses built on rafts. Fishing, fish curing by salt and sun and collecting water chest-nuts ( Singhara ) is their sole activity for livelihood.

Manipur is surrounded by hills and hill tribes. To the south are Mizos, to the west are Kukis and to the north are Nagas, some among the different group of the Nagas being head hunters. Often a man becomes eligible for marriage if he has a human head to his credit. Many Nagas eat dog meat. So dogs are rare, as they are eaten up. Many Nagas have been converted to Christianity.

In NEFA there are a large number of tribes such as Daflas, Abros, Mishmis and so forth, who were practically untouched by modern civilization. It is only after Independence and specially after the Chinese incursion that they are coming in contact with the people of the plains. Naturally they could preserve quaint customs. They wear curious dresses. It is not uncommon to find some one naked. Some are peaceful and friendly while others consider decapitating men as a sport. They are gradually getting changed their customs and habits owing to the intermixture with the people of the plains.

In nearby Meghalaya almost the whole of the Khasi community has embraced to Christianity. But the society is matriarchal. Women are owners of all the property. Khasis still strongly resent their women marrying people of the plains or other community.

In Bhutan Lamaism is strongly entrenched which spreads through Sikkim to Nepal. It reappears in Ladakh.

• In Sikkim and Darjeeling the original inhabitants are Lepchas. • They were invaded from the north by Tibetans, from the east by Bhots, from the west by Nepalis and

from the south by the Bengalis. The first two practice Lamaism, while the last two practice Hinduism.

Nepal had been rather isolated. Yet Rajput invasions from the plains have occurred. The Gurkhas of Nepal, though short statured, are well-known for their bravery. They have proved their skill as soldiers in most modern warfare. They are literally fearless. Nepal is known for their honesty and popularly known as Bahadur (a brave man). A number of them are employed in the watch and ward duties in the plains. They are simple and cheerful. They spend much for their clothes.

The Dotial porter of Nepal do brisk business in Garhwal where they carry goods for the pilgrims to the religious places of Uttarkhand. I still remember Kulebhan or Dotial porter who travelled 300 kilometres with us carrying 40 kilograms on his back. He was sure-footed, honest and dependable.

Compared to Dotials the Garhwalis are slow. They could grow much fruits and vegetables, eat them for themselves and sell it to pilgrims. Yet many of them have the profession of Panda, a guide and religious helper to the pilgrims as well. There was a custom of women and children, asking for needles and thread from pilgrims. They also construct small temples of Garur, Hanuman, Bhairon or Ganesh to collect offerings from pilgrims. The Chatti system, where pilgrims stayed free of cost on the condition that they should purchase their rations from the Chatti owner, is first disappearing as roads are advancing into the mountains. The pilgrims now can cook their own food. Hotels also are coming up these days. On the whole, the activities of Garhwalis are oriented towards serving and earning from the pilgrims. The hill people of this region are known for their straightforward dealings and honesty, specially on pilgrim routes. Theft is unknown. It is a usual custom to deposit extra articles in Chattis before one climbs up. One may be sure of their safety: Perhaps in time vices will creep up into these valleys.

In Kinnaur noticable culture change is in process. Kinnauris are Hindus. They have their village Deotas ( folk dieties ) like those of the people of Kulu. Villages are curiously located on knife-edged ridges. In Kinnaur grapes are cultivated. They also grow wild grapes. A kind of wine called Angoori is made out of them.

The Gaddis of Kulu are semi-nomadic people. They too are Hindus. Their acculturation will be treated in a different chapter.

In Jammu and Kashmir a variety of people live. In Ladakh are found Ladakhis who practice Lamaism. The cultural landscape is adorned by Gomphas ( monastries ) and Mapis ( burial statues ). Barley is their main grain. It provides food and it is fermented to produce drink. They are not in the know of growing fruits or vegetables. They thus dry small pieces of meat that are to be eaten in winter. Solidified cubes of yak cheese are chewed by them in Leh as well as in Darjeeling.

The western half of Kashmir is dominated by the Muslims. Here women have no Purdah. The Muslims of the vale of Kashmir are known for their handicrafts, embroidery, silver wares, stones, walnut curvings, fur goods and willow baskets, etc. There are a few Kashmiri Pundits who live in the valley. They are great intellectuals and have much power. Our Late Prime Minister Jawahar Lal Nehru was one of them. South of Pir Panjal is predominated by the Dogras, who came from Rajputna. They are the ruling class today. In the high mountains and forests live semi-nomadic Gujars who are Muslims. They keep flocks of buffaloes and sheeps.

This short description of the people of the Himalaya clearly reveals the great variety that are found among these colourful people. Greater details of these will be found in micro-regional studies in different chapters.

## Village Location

People of the Himalaya, specially those living in the remote inaccessible valleys and high glaciated regions, may safely be called 'naturvolkers.' They and their ancestors have been living in the thick of nature for hundreds of centuries. It is but natural that they have shown an uncanny skill in choosing correct sites for their settlements. The people from the plains going out to the Himalaya to do social work may make mistakes in choosing sites for new buildings. It is therefore necessary to have a correct appraisal of geographical environment as related to siting of buildings and villages in the Himalaya.

*Location Mistakes :* An interesting example of wrong judgement is provided by the attempts at the construction of a new rest-house by the authorities near Pindari Glacier, two kilometres ahead of the old Dak Bungalow at Phurkia. To a casual visitor from the plains Phurkia seems to be wrongly located. It is built on a narrow ledge, hanging 300 metres above the bottom of the gorge cut by the Pindar river in a thick deposit of glacial till. The Bungalow is hemmed in by huge boulders on all sides so that the view is much obstructed. But the site is stable, free from dangers, and has existed for a long period. A site, two kilometres ahead over a flat glacial terrace, would have provided a much better view of Nanda Devi and its neighbouring snowy peaks. And so the authorities went for this new site. The newly built rest-house was, however, obliterated within a year by an avalanche. It was literally shot down into the gorge below. Strangely the rest-house was reconstructed at the same place and was destroyed once again. The site was on an avalanche route. Similar mistakes have been made at Klapa, the new capital of the

newly constituted Kinnaur district in Himachal Pradesh. In fact, perhaps a bigger mistake is being made here. Chini the old Kinnaur village is situated on a steep knife-edged spur, just looking up towards the sky the dazzling group of snowy peaks crowned by the sacred Kinnaur Kailash, and down from its eerie position into the Sutlej gorge below. Such an odd location is much to the liking of the Kinnaurs, and has perhaps some advantages for them. The administration started building the new capital of the district a couple of kilometres away at Kalpa on a comparatively gradual slope below the snowy range above. Here some slopes are passageways of avalanches, which cannot touch Chini. According to S. D. Kaushik some buildings of Kalpa were destroyed by avalanches. Moreover, an administrative capital should not have been built for nothing lofted a few thousand metres above the strategic valley route along the Sutlej from Simla and Rampur towards Pooh and Shipki. Realising the mistake, it is now being proposed to shift the capital site from Kalpa to Peu five kilometres below.

Choice of village sites is controlled by many factors physical as well as cultural. Among physical factors the greatest control is exercised by land forms, such as river terraces, gentle slopes, drained out lake bottoms, stable talus cones and fans, glacial terraces and so forth. Availability of agricultural land, good soil and easy supply of water for drinking and irrigation are other physical factors which influence village location. Among cultural factors are sites on hill routes, road junctions, Chattis on pilgrim routes, locations near passes, religious centres and temples.

*River Terraces :* River terraces are perhaps the most popular sites for locating villages in the Himalaya. They mostly occur in valleys between one to two thousand metres above sea level. Here the climate is mild. The alluvium of the terraces provides good soils. Irrigation water is obtained from streams descending along the flanks

of the terraces from above. The streams are dammed above the terrace level, and channels are built to divert the water to the fields on the terraces. Villages are located at the upper edges of the terraces or on mounds. In the Alakananda valley terrace villages begin to occur from Kirtinagar onwards to Srinagar, Gauchar, Chamoli and Pipal Kothi. Terrace villages in the Bhagirathi valley spread from Tehri to Dharasu, Uttar Kashi and Bhatwari. In the Yamuna valley they occur around Barkot and Gangani Chatti. The village of Kuthnaur is situated on a hanging terrace. In the Sutlej valley there are very well developed terraces at Tattapani north of Simla. From here they continue beyond Rampur, and occur in broken stretches even up to Karchham. The Sholtu Rest House at Tapri is situated on a detached terrace. Villages, cultivated fields and orchards, producing grapes, apricots and pears are situated on terraces along the valley beyond Karchham. In the Beas valley terraces spread from Kulu to Manali. Examples of terrace villages may be multiplied.

*Lake Bottoms:* Drained out lake bottoms and other inter-mountain plains provides sites for dense rural settlements in the Himalaya. The sudden rise of some middle Himalayan ranges, such as the Pir Panjal and Mahabharat Lekh cut off and dammed some small rivers, producing lakes. The best example of such a phenomena is provided by the damming of the river Jhelum, and the creation of a lake where the beautiful vale of Kashmir is found to-day. Fluvio-glacial deposits filled up this lake. The lake ultimately drained through a cut near Baramula, exposing the flat bed of the lake. Terrace like formations of lacustrine deposits ring round the vale. Today it is densely populated.

The damming of the Baghmata by the Mahabharat Lekh in Nepal also produced a lake, which after draining through the Chhobar gorge, produced the vale of Kathmandu. It is the most densely populated part of

Nepal today. Again in western Nepal the Seti Gandak was dammed by the Mahabharat lekh to produce the densely populated Pokhara valley. The village of Pokhara has an ideal rural settlement pattern, consisting of a broad avenue spreading north-south along this elongated valley for six kilometres. In the middle of the avenue runs a raised platform on which stand shaded trees and temples, an ideal resting place for travellers, specially those carrying loads. Streams of clear water run along the edges of the avenue, where women wash clothes and clean utensils and ducks play in the water. The avenue is lined by shops and dwelling houses. The vale of Manipur is the fourth example of a densely populated drained out lake bottom in the eastern Himalaya.

As example of flat densely populated intermountain plains one may note the plain around Baijnath in Garur valley, below Kausani in Almora district. Another such plain is found near Mandi in the Beas valley in Himachal Pradesh.

*Altitude* : Usually between an altitude of 2,000 and 3,000 metres the Himalayan valleys have a glaciated topography. Here the valley bottom are flanked by tremendous vertical rock cliffs, which consist of spurs truncated by past giant glaciers. They form U-shaped valleys in which the present rivers are engaged in cutting narrow V-shaped gorges. Here there is little space for locating villages. There may be small strips of level land just along the rivers, produced by lateral corrosion, or gentle talus cones or fans made by tributaries deducing into the main valley, where villages are located. Such village locations may be seen in nearly all the major river valleys in the Eastern, Central and Western Himalaya, such as those of the Subansiri, Mana, Jaldhaka, Tista, Kosi, Gandak, Ghaghra, Pindar, Alakanda, Bhagirathi, Yamuna, Sutlej, Beas, Ravi and Chenab.

But in such situations there are gradual slopes on shoulders above the truncated spurs. Large villages

spread out in such places. A good example is Joshimath in the Alakananda valley. The village sites avoid places which are in danger of flooding, or where there are chances of rock falls, land slides or avalanches.

*Glacial Terraces* : In the higher glaciated regions above an altitude of 3,000 metres fluvio-glacial or glacial terraces are used for settlement. The village of Kharsali in the Yamuna valley is a good example. Kedarnath and the small settlement surrounding it is also situated on a large glacial terrace or platform. The monastery of Thyangboche below Mount Everest also stands on a glacial platform.

Glacial terraces are also used for temporary settlement by semi-nomads. The terrace of Zoipal on the route to Amarnath in Kashmir is used for such a purpose. Besides, it is used as a camping ground during the pilgrimage to Amarnath in August. Further up a huge glacial terrace in Panchtarni in the Sindhu valley is used as the last camping ground for the same purpose.

Sometimes in the high Himalaya some glacial streams may be plugged by old glacial moraines, and produce temporary lakes. When drained they form good sites for rural settlements in high glaciated regions. The Baspa valley around the village of Sangla is a good example of such a situation. Sangla spreads out in a line over a transverse ridge formed by an old terminal moraine, a situation which makes it safe from floods and avalanches.

*Amphitheatres* : Settlements are also found in past glacial amphitheatres such as the village of Badrinath in the Alakananda valley. The village of Beef in the Yamuna valley is also located in an amphitheatre.

Tri-junctions of rivers in glaciated regions in the Himalaya are often formed of fluvio-glacial material deposits in the form of flat triangles. In such regions formation of eroded material by frost action is much greater and produced faster than the agents of transportation can remove it. Hence it accumulates at suitable points, and



river tri-junctions form a suitable site for accumulation of eroded material. The triangular flats thus formed are good sites for settlements. Pahalgam in Kashmir at the junction of Liddar and Aru is a good example of such a site. The big village of Padam in Zaskar is another such example.

In glaciated regions villages are sometimes situated on stable talus cones. The village of Mana in the Alakananda valley, and the village of Nilang in the Jadh Ganga valley provide good examples of this type. The old village of Manali is also situated on a talus cones.

*Avalanches* : The villages in such high altitudes avoid sites where there is danger of avalanches. Along certain slopes avalanches come down periodically. Some times the period is long, even five or more years. The town of Badrinath is demolished after every five or ten years by avalanches dropping down the slopes of Narayan Parvat, on whose higher slopes snow accumulates for a number of years till it reaches a critical condition and thunders down as an avalanche. Some remedial measures suggested by the Geological Survey of India have been of little avail. The only way to save the town from periodical destruction is to build it on the other bank of river Alakananda. The present town is wrongly situated. Unfortunately the temple cannot be removed from the present place, as it stands over Tapt Kund (hot spring), a sacred site.

*Twin Villages* : Of special interest is the siting of Talla and Malla villages of the semi nomadic people of Garhwal, such as Johars of Milam valley. They build pairs of villages on transhumance routes, which were also used for trading purposes in the past. Johars live in houses in Malla villages in summer, and move down to Talla villages in winter. They may even move to Bhabar sites during winter.

Anwal shepherds of the Pindar valley build stone huts in alpine meadow called Bugiyals at a height of 4,000 metres. They live here during summer as their flocks of sheep graze on rich alpine grasses. Gujars in Kashmir

build huts of solid logs near the tree line. They are very sturdy in construction, and their heavily built roofs of solid logs and mud can withstand the heavy snow fall in winter. The Gujars, however, live in them during summer. The Ski Club building at Khilanmarg has been built on the model of a Gujar hut, so that its excellence was recognised by its builders.

*Junctions* : Some villages are built at the junctions of two types of regions. In the vale of Kashmir villages are built at the base of Karewa cliffs, such as the village of Martand or Tanmarg. Another example is that of villages located at the junction of hills and plains. Such are the sites of Jammu, Kalka, Kathgodam, Koilabasa and Siliguri.

*Water Supply* : Village sites are often controlled by water supply position, and villages are located where a spring supplies drinking water. The Voelutian spring of the vale of Kashmir pouring out volumes of sparkling water from underground streams in limestones have provided sites for large villages like Verinag, Achhabal, Anantnag, Martand, Chashma Shahi and so forth.

An interesting case of spring sites is also found in the vale of Kathmandu. Here the Karewa like lacustrine deposits are formed by beds of sand and clay, which stand as 100 metres high bluffs. The sandy beds act as aquifers and springs come out of their bottoms, where they outcrop just above the impervious clay beds. Big springs gush out at these points. Masonary tanks are built around them with crocodile or lion heads discharging water, which is used for drinking, washing and other household purposes. From bigger springs water is also used for irrigation, such as paddy seedlings in May.

Yet another interesting case is the line of fissure springs situated between Dagshai and Sabathu in Simla Hills. The springs provide sites for villages, and their water is also collected in a pipe in line, which supplies water to neighbouring towns. Hot springs also provide sites for

villages. People come to the springs to bathe in medicated, sulphurous or radio-active waters. Some religious sentiment is also associated with hot springs in many cases.

*Natural Calamities* : Sometimes sites are chosen to avoid natural calamities, such as avoiding places where there is a possibility of land slides, rock falls, rock bursts, floods and avalanches. Perhaps the peculiar location of villages in Kinnaur on sharp knife-edged ridges is to have cent per cent safety from avalanches. The village of Kamru in the Baspa valley spreads in a linear fashion on the top of a lone steep ridge. The village of Chaura on the border of Kinnaur district is also situated on a sharp knife-edged spur projecting into the Sutlej gorge. The case of Chini has already been mentioned. Another reason for spur top location in Kinnaur may be for avoiding cold, frosty night air which rolls down into the valley bottoms. Spur top location will also be sunny and dry. Precipitation in the form of rain or snow will also slip down easily. This location is also good for defence, and safe from wild animals.

The Himalaya has been supposed to be the abode of gods from times immemorial. Here are situated hundreds of temples and shrines sacred to Hindus, Buddhists and other religions. These sacred spots become sites for villages. Among famous Himalayan shrines of the Hindus are—Badrinath, Kedarnath, Tungnath, Joshimath, 'khi-math, Gupta Kashi, Triyugi Narayan, Gangotri, Uttar Kashi, Yamunotri, Manikaran, Amarnath, the sacred cave in Kashmir, Vaishno Devi, a spring site near Jammu, Pashupatinath in Kathmandu, Muktinath in the upper Krishna Gandaki valley and so forth. There are numerous Buddhist monasteries some of these are very famous, such as Tawang in the North East Frontier Agency, Svayambhūnath in Kathmandu, Thyangboche below Mount Everest, Hemis in Ladhakh and so forth. A strange religious centre is Rawalsar lake near Mandi, where there are shrines of Hindus, Buddhists and Sikhs. There are a number of floating islands in the lake which have made it so sacred.

*River Junctions :* River junctions are also supposed to be sacred places where villages are located, such as Dev Prayag, where the Alakananda meets the Bhagirathi, Rudra Prayag, the meeting place of the Alakananda and Mandakini and Karna Prayag where the Pindar joins the Alakananda. Further up is Vishnu Prayag where the Dhauli Ganga meets the Alakananda. There are small villages along pilgrim routes called Chhattis. With the development of motor roads on which public buses ply, the Chhatti system is gradually disappearing which have been mentioned previously also.

Bridge and other river crossings make sites for village such as Khalatse on the Sindhu on way to Leh. Some of these bridge crossings also become road junctions. A good example of this type of village is Tista near the bridge over the river Tista below Kalimpong. Barkot in the Yamuna valley has the same situation. There are village sites on caravan routes in the Himalaya. They provide shelter, food and grazing for mules. Examples of such villages are Pandra Mil on the Nathu La route, Thajewas near Sonamarg, and many others on the route to Leh from Srinagar and Manali, routes to Spiti and the Karakoram Pass.

The above provides some idea of the great variety of factors which influence village location in the Himalaya.

## Urban Location

Of the trinity of micro-regions, which are also the three major geomorphological components of the Indian sub-continent, namely the ancient stable block in the south, the stupendous wall of young fold mountains in the north, and the vast alluvial plains of Sindhu (Indus) and Ganga in between these, the northern mountain wall is the most powerful in influencing the geography of India.

Geomorphology in this region plays a very important part in moulding human activities. It is more so in steep and rugged landscapes, where river terraces, alluvium filled basins, the degrees of slope or ruggedness, the past glacial amphitheatres, and over and above all, the present altitude determine human enterprise and occupation. The lay of land and the pattern of valleys and ridges control the routes through, and over them, and also the flow and intermixture of culture.

The first range of hills, the Siwaliks is fairly continuous in western Himalaya. Behind it there are a number of strike valleys called *Duns*. The transverse rivers which cut through the Siwaliks are often short swift streams, which rush down during rains, but are otherwise dry. They spread out on the plains huge fans of boulders. The little water in them is soon lost amidst gravel and boulders.

In Kangra, Hoshiarpur and Ambala these gravelchoked rivers are called *Choas*. In Uttar Pradesh the tracts covered by such gravelly porous soils are called Bhabar. Nomadic people of Kumaon and Garhwal come down to these places with their herds of cattle in winter. They have often lands allotted to them for use. They live in temporary huts and carry out trade with the plains people.

Behind the Siwaliks the Duns are famous for high quality rice cultivation on alluvial terraces. The boulder strewn areas are left to be grazed. The Siwalik ranges are below 1,000 metres in height. They are rugged and forested and yield timber. They are unpopulated. Roads and railways pass through them usually through gaps produced by rivers, such as at Hardwar by Ganga.

North of the Duns the ranges rise one above the other. They are often very rugged and forested. They are affected by land-slide in monsoon rains, specially where the soil is loose and there has been too much grazing and deforestation. Up to 1,200 metres the cultivation is patchy and habitations few and far between. The climate is suffocating in summer and people prefer higher and cooler slopes above this height.

*The Optimum Belt :* The optimum weather condition for comfort, specially in the hot summer months of May, June and July are obtained at an altituded of about 2,000 metres. In a belt 500 metres above and 500 metres below this level the Himalaya provided the British suitable sites to build their hill-stations and cantonments, where the white soldiers could escape the summer heat of the plains. The British civilians-went to them with their offices in summer. The locations of these towns are quite recent. Ruggedness or lack of level surfaces did not prevent the British from siting them there. Water also could be provided by springs or reservoirs fed by rain, or lifted by electric-pumps. Small hydroelectric power stations were erected wherever necessary. The most numerous towns of this type are found in Simla hills. Simla was and is the largest Himalayan hill station. It was the summer capital of India and the Punjab, and now is the capital of Himachal Pradesh. Kasauli, Solan, Dagshai, Dharampur, Jutogh, and Sabathu are other cantonments in Simla hills. A hill railway was also constructed by the British to improve transport in this area. In Uttar Pradesh hill stations and cantonments were established at Nainital, Ranikhet, Musscorie, Chak-

rata and Lansdown. Dharamsala and Dalhousie in the Punjab are two other creations of the British. These towns seem to have survived the set-back they had on the departure of the British, though some of them, such as Dalhousie (with all its beautiful forests) are still in the doldrums. Dharamsala has been made the head quarters of the Dalai Lama and his entourage. Darjeeling, Kalimpong Kurseong, Gangtok and Kohima are also situated in the optimum belt in eastern Himalaya.

Hill people in this belt are extremely hardy. The climate being salubrious, the population has grown rapidly leading to extensive use of terraces. Wherever the slopes are gentle, and flat terraces and water is available, paddy is grown. In undulating terraces maize is preferred. In cool, damp, places with the proximity of coniferous forests, *podzols* have developed. Pressure of population is forcing the people to extend cultivation by rotation in lands higher as well as lower than the optimum belt, called *upraon* and *talaon* cultivation in Almora. A progressive deforestation is the result, which is bound to have adverse results in future. Agricultural population is mainly concentrated in the optimum belt, roughly between 1,300 metres and 2,600 metres.

The ingenuity of the people is reflected in the canals they make to divert stream water to various levels, in difficult hill terrain. They also run small watermills or *panchakkis*, using the power of dropping water.

Local variations occur in this belt according to slope and topographical details. Villages are located on gentler slopes. River terraces are invariably occupied by paddy lands and are densely populated. Large villages and even towns grow up near terraces. A typical example is Bageshwar in the Sarju valley which stands near a large crescent shaped terrace.

A number of Rajput princes penetrated into the rugged hill ranges of Himalaya to escape molestation from powerful Muslim nababs and emperors. They founded small

kingdoms here in isolated valleys. Chamba is one such town, past capital of a State of the same name. It stands on a huge terrace along the river Ravi. A double terrace on the opposite bank provides land for growing paddy. In Kulu, the capital of a prince, spacious terraces on both sides of Beas run for nearly 15 kilometres. They are densely populated. Advantage is taken of the level ground to hold one of the largest hill fairs in Kulu. Such fairs, are a feature of the social life of the people. Here the plains people mingle with hill people, while the nomads living in high hills above also come down. The fairs usually have a religious background, but are chiefly of a great economic and social value.

Even today marriages are contracted in the Kulu fair. But the centre of attraction is *Raghunathji*, the Chief God to whom gods from surrounding villages come in procession to pay their annual homage.

Other hill fairs worth mentioning are held at Bageshwar, north of Almora and Jauljibi bellow Askot on the route to Manasarowar.

Alluvial filled basins also provide land for cultivation and account for the location of towns. The basin of Baijnath in Garur valley, 40 kilometres north of Almora, is an example. Another conspicuous basin lies between Mandi and Sundargarh, two past princely capitals. It is an oval shaped basin with its major and minor axes about 15 and 10 kilometres in length.

But the largest of such basins is the vale of Kashmir streching for about 50 kilometres on both sides of river Jhelum. Though its palaeogeography is rather obscure, it is known that in Pleistocene, the uplift of Pir Panjal range to its present diamensions, made it a large glacial lake in which descended glaciers from the surrounding mountains in the post-Pleistocene glacial periods. Fluvio-glacial, Karewa deposit filled the lake bottom and today Karewa beds ring round the valley as raised platforms. In the central portion of the valley, they have been washed



away by the Jhelum, which meanders through its alluvial flood plain. The *lip* below Baramula through which the Jhelum escape to the Punjab plains is not sufficiently low and has thus resulted in incomplete drainage of the valley creating lakes and marshes, which in due time will become dry land as the lip is cut deeper and alluvium fills up the depression. Srinagar, Anantnag, Gulmarg, Sonamarg and Pohelgam are located in the valley

South of Pir-Panjal is the Chenab valley, river terraces are extensively developed, specially the terrace town of Kishtwar, which however, is just north of Pir-Panjal, where Chenab escapes through a deep gorge cut into it. A motor-road from Batota to Bhadarwah partly follows these terraces.

Along the Kali river forming the border of Nepal and India, town sites are in amphitheatre like basins occurring near the head-waters of small tributaries of Kali. Such is the large basin of Champawat and of Pithaura Garh, a newly formed district. Paddy fields spread all over the rolling landscape, except on swells where red tufted *Chua* or a millet called *Marua* are grown. Loha Garh and Askot are also located near comparatively broad and open land. On a large terrace at the junction of Dharma Ganga and Kali at Jauljibi a big hill fair is held. The fair at Bageshwar at the junction of Sarju and Garur Ganga is also very important for the hill people.

The *Bugiyals* or Alpine pastures of Garhwal and Kumaon are abodes of Anwals in summer. In this region, however, unlike Kulu and Kashmir, the nomads are only men folk. They may be called professional grazers. They are paid for the work they do for others. Usually the sheeps, goats or horses belong to others. The *Johars*, however, are nomadic traders. They have dwellings at three levels. The middle ones are their main homes, while the upper and lower ones are used when they migrate in summer and winter respectively. The animals including sheep and goats carry goods and merchandise for them.

The Marches, similarly use the Niti, Mana and other neighbouring passes along the Tibetan border for similar purposes. But the new political situation has hampered their movement, and their foreign trade with Tibet has completely disappeared.

In Kashmir these nomads are called *Gujars*. They live in log huts built just below the tree line, so that they can roam about with their flocks on high pastures. In winters they descend to low levels. In Kulu the nomads are *Gaddis*, who roam on high grassy talus cones or pastures with their animals. They have permanent houses and agricultural lands in low valleys in the optimum belt. But young men and women go up to high pastures in summer.

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## The Semi-nomads

Transhumance is nearly a universal phenomena in mountain habitats, dictated by the altitudinal change in temperature. Himalaya is no exception to this rule. However a great variety of practices are observed in Himalayan semi-nomads, who live under varying physical conditions in different Himalayan valleys. These nomads were originally people who lived in the thick of nature in secluded valleys of high Himalaya. The environment has made them self-reliant, sturdy, simple, cheerful and happy generally. In some cases they are peace-loving and hospitable, and in others, ferocious and unsocial.

Their peaceful ways of life are being vitally affected by changing circumstances such as the slow but sure penetration of modern civilization in their midst, and also the increasing political tension with China and Pakistan nearly all along the Himalayan frontier. Development of roads has been taking place all over the mountains in the normal way. This has been accelerated by military and strategic exigencies. Even in peaceful times, there has been a rapid increase in the number of outsiders, such as tourists, hikers, mountaineers, adventurists and pilgrims to the holy shrines. Political tension has brought military encampments right in the middle of nomadic people. All the above factors have brought about a change in the habits of the Himalayan nomads.

*Gujars of Kashmir* : Gujars inhabit the higher regions in the Himalaya in Kashmir. They are Muslims. Their summer habitations are permanent structures of solid deodar log walls and roof, with openings for entrance towards the down slope, with a metre high wooden wall

above the ground, and a gap above it, which is closed at night. The roof slopes backwards, and is covered by a thick layer of mud. The Gujars inhabit them during the summer, when they roam with their flocks of sheep and goats on the higher alpine pastures. They also keep herds of buffaloes. Those Gujars who live near the inner rim of the valley come in contact with the settled folk of the valley, the Kashmiri cultivators. The Gujars speak in a language which is more akin to that of Punjabi. They dress differently and do not pull on well with their Kashmiri neighbours.

With the rapid increase of tourists and "hikers" in the vale of Kashmir they often come in contact with them. They make daily trips to Gulmarg and Pahlgam to supply milk, butter, cheese and mutton. They even offer service to become guides for tourists to visit places of interest. At Baisaran, a small meadow surrounded by dense forests, about 1,000 metres above Pahlgam, they have a small village.

During the influx of pilgrims in August to visit Amarnath, the nomadic Gujars are increasingly supplying porters and ponies to the pilgrims. But as compared to their Kashmiri counterparts, who have been engaged in this trade for generations, the Gujar porters are unreliable, and their ponies more than often throw down their riders.

Gujars living in remote interiors or on the southern slopes of Pir Panjal and in Kishtwar and Bhadarwah have changed lesser. Gujars can walk fast long distances, and in their long annual treks, they go down with their flocks to the distant plains of Punjab at the advent of winter, and back again in early summer. But some Gujars, who earn money otherwise, sometimes prefer to stay back in the vale of Kashmir.

The creation of the "Cease Fire Line", sometimes through their summer habitate or across the routes of their annual treks, have created unsolvable problems for

them. Their herds often stay across the "Cease Fire Line" and are caught by authorities on the other side, together with their owners, sometimes. The normal ways of life of the Gujars are thus being changed by circumstances.

*Gaddis of Upper Beas* : These gay and cheertul nomads inhabit the snowy ranges of Dhaula Dhar and Pir Panjal in the upper Beas valley. Unlike Gujars who are Muslims, the Gaddis are Hindus. Fortunately, their habitat is nowhere contiguous to the Indo-Chinese border. There is an increasing extraction of timber and the Gaddis do not like their forests to be mutilated. Gaddis have permanent habitations in villages near the valley bottoms. It is generally the young men who go up with their flocks of sheep and goats to high pastures in summer. Here they live a very hard and adventurous life, and often stay in caves. They may even have to fight bears and panthers who kill sheep. In this they are helped by their powerful sheep dogs. They are full of fun and frolic, and hence they gather at the famous Kulu fair, where they come in close contact with the people of the plains. There is much trade for them. They sell raw wool and woollen goods and purchase modern products like electric torches and transistors. This contact is on the increase. The slow process of modern civilization is continuing. But the Gaddis love their traditional way of life.

*Bhagirathi Valley, the melting pot of Nomads* : The principal habitat of semi-nomads in the Bhagirathi valley is the catchment of Jadh Ganga, a tributary of Bhagirathi, which it joins below Bhairon Chati. Here live Jadhhs, the original nomads of Bhagirathi. They have their summer habitations in a fairly compact village named Nilang. They do not have scattered habitations like the Gujars. Here they even cultivate some barley and wheat during summer and with their families. They roam with their flocks in the surrounding pastures, while women folk look after agriculture. Nilang is at a height of 4,000 metres. In autumn the Jadhhs come down to a lower

village named Barari in the Bhagirathi valley 1,000 metres below Nilang. Women, children, old and infirm stay here during summer, while young men move further down with the sheep. At Barari blankets and other woollen goods are made. The Jadhs have thus two houses, one in the upper level, and another lower down. The Jadhs have been forced to change their habits quite a lot, because their habitat has its northern frontier along the Chinese border. This has resulted in the building of a motor road upto Nilang. A number of Jadhs did some barter trade with Tibetans across the border over the Jelukhaga pass. Another kind of nomads called Bhots, who are found nearly all over the Himalaya, also carried out the same kind of trade. The tension with China has completely stopped it. The majority of the Bhots have preferred to stay in India. Here they have settled among the Jadh villages. Some of the Bhots have been inter-married with the Jadhs. Bhots are Buddhists, while Jadhs are Hindus. Moreover, Bhots eat beef. Hence the Jadhs, who have mixed with Bhots are taken as outcastes by the Hindus of Bhagirathi valley. Some of the Bhots are rich.

The Jadhs and the Bhots are therefore changing habits rapidly. The Jadhs employed by Bhots are taking tea in Bhot fashion by pounding tea ( brick type generally ), yak butter and salt in a wooden cylinder and adding hot water to it. Many Bhots have taken to Punjabi attire. The women wear Salwar, Kurta and Dupatta with ease. The Bhots still do some trading in mountain commodities and plains products. They move down with their flocks of sheep and goats to tower altitudes in summer, in the valleys below Uttar Kashi, Dharasu and Tehri. While walking down, they do not even hesitate in using buses for going down, while some members keep with the flocks.

Besides Jadhs and Bhots, we find strangely enough Gujars of Kashmiri origin living on the higher portions of Yamuna-Bhagirathi watershed in the same condjtions as in Kashmir. They migrated to this area a few generations

ago. They mainly keep buffaloes. They are Muslims and adhere to their previous habits. But the change of habitat will sooner or later affect them. As in Kashmir they travel long distances, and come down to the forests of Rishikesh during winter. The Government of India has been trying to settle them permanently in the jungles of Rishikesh. If this plan is carried out, it will completely change their mode of living. But it may seriously affect their health, because they will badly miss their healthy summer environment. Lack of physical exercise, to which they are used may further damage their health.

A few Gaddis have also migrated from Kulu to Bhagirathi valley. They are easily recognised by the long rope tied round their wastes. But only the older Gaddis still use the rope, the younger generations have discarded it, and may soon merge with the Jadhvs.

Bhagirathi valley may rightly be called a melting pot of Himalayan nomads.

*Marchyas of Mana* : This is a small group of Himalayan nomads who live in the upper Alakananda valley. They are in many ways similar to Jadhvs. They live in a big village called Mana four kilometres north of the famous shrine of Badrinath. In winter they leave the village and move down to Joshimath or Chamoli. Their flocks of sheep move further south and down into warm valleys. Marchyas are Hindus. Some Bhots are also found here. The Bhots and the Marchyas did some trade with the Tibetans before the tension with the Chinese. Further a motor road has now been built upto Badrinath. Military encampments have also been established upto the border. There is a great rush of pilgrims and sight-seers throughout summer. Mountaineers also visit the area to climb peaks like Nilkanth, Chaukhamba etc.

All the above facts suggest to make Marchyas "civilized" in modern sense. Mana is also a Development Block and a school has been established in a village, where children of these semi-nomads are getting educated. There are

extensive grazing pastures all around Mana, where men roam with very large flocks of sheep and goats. They also keep cattle and a few yaks. Cross breeds of these are also found. Women work in the cultivated fields. Wheat, barley and potatoes are grown all around Mana on extensive fluvio-glacial terraces.

Marchyas are now coming in close contact with the people from the plains. Willy nilly they have started helping them in various ways, and earning money in exchange. They provide mules to all kinds of visitors for transporting their luggage. They are also engaged as high level porters and guides by mountaineers. They serve military in many ways, specially providing transport, labour and food, which includes live sheep for mutton.

*Anwals of Pindar Ganga :* Anwals are semi-nomads by profession. Any hillman of the region, who engages himself in the work of herding in high pastures becomes an Anwal. He is paid for his work in kind. The Anwal who has few sheep or cattle of his own is rare to find. The Pradhan of the village arranges the whole affair. At the advent of summer owners of animals and Anwals go to him, when he distributes the animals among the Anwals offering to do the work. He charges a small fee for it. He also arranges the price for the work, which consists of some wheat flour, *ghee*, *gur*, salt etc. The Anwal then takes his flock up in the high pastures called Bugyals. The pastures are also divided among various Anwals, the boundaries being marked by streams. The Anwal is not responsible for the loss of a sheep, if it is killed by a leopard or a bear. But he must produce a part of the body of the animal killed, say a hoof, and give it to the owner. The Anwals build stone huts at great heights for shelter. Like many other Himalayan semi-nomads, they keep sheep dogs to help them.

This system of Anwals is very well arranged and continues even today. But some changes have occurred. A landlord of Loharkhet has engaged a family of Anwals to work



for him permanently. He gives them board, lodging and some wages. Payment for herding in cash instead of kind may start sooner or later. The motor roads have also come nearer to them. Tourists are coming in large numbers to visit the Pindari glacier. Mountaineers also come to this area to climb the Nandakot group of peaks or to go upto the Trail's Pass or Pindari Kanda. Pindar is a closed valley, and does not lead to any border passes. So there has been no trade. Tracks leading to the Bugyals will not be changed to motor roads. The disturbing factors in the normal ways of life of the Anwals are fewer.

*Johris of Malla Johar* : The habitat of this nomadic tribe lies in Milam and other adjacent valleys near the border. Routes from this region lead across Kungri Bingri, Sha'shal and other passes to Tibet. The Johris have combined trading with nomadism and herding, and have followed a systematic method of altitudinal migration related to the seasons, and their profession of trading and herding. It has been very well described by S. D. Panth in his book on Kumaon Himalayas.

The Johars have two villages of the same name with prefixes "Talla" and "Malla", which mean lower and higher. The lower villages are at a height of about 1,500 metres and their higher counterparts at about a 2,500 metres on the routes towards the border passes. Each Johar family has one house in the lower village and the other in the higher one. The lower village is more important. Here the family has cultivated fields, orchards etc. Also the family lives here except in winter. The higher houses are used as store-houses or resting places for trading and herding.

Before the tension with the Chinese started, the Johars made two or more trips up and down to bring plains goods to the higher houses. Sheep and mules are moved up and down to carry the goods. Sheep and goats carry goods in small leather bags called Karbozas. Women and children also visit the upper houses. In summer only

men with laden ponies went to Tibet across the passes for barter trade. They brought back wool and other Tibetan goods. In autumn the higher houses were closed, and the nomads went to the lower houses. In winter these houses were also closed and the whole family laden with bags and baggages and also the Tibetan goods, together with the herds of cattle, ponies, sheep and goats moved down to the Bhabar lands along the foot of the Himalaya. Here the families lived with their animals who grazed for the winter in Bhabar. Lands are allotted to the families for this purpose. The men visit city markets, go as far away as Lucknow, Kanpur or even Bombay and Delhi to sell the Tibetan goods and purchase plains' goods to sell them to Tibetans in summer. As winter neared its end, the Johri caravans moved up to the mountains again.

With the end of trade with Tibet this elaborate system of nomadism has received a mortal blow. Many Johris now do not travel down to Bhabar. They may come down only upto the markets of Almora or Ranikhet. To give alternate employment to the Johris the Government of India has been helping in the development of cottage industries, such as making blankets called Thulmas, small carpets called Chutkas, wooden and cane goods and deer skin products. On the Tejam route the big village of Munsiri has been made the centre of a Development Block. An electric generator has been carried to it on the back of mules to help in the development of cottage industry. A small hydroelectric power station has been set up at Bageshwar. There are schemes for further generating hydroelectric power by small generators. Irrigation canals are being constructed along the contours to develop cultivation. Attempts are being made to encourage fruit culture by distributing seedlings of apricots, plums, pears, peaches and apples from the Government fruit garden at Chaubattia in Ranikhet. An agricultural research station has been established at

Havalbagh below Almora under the direction of the eminent Botanist, B. Sen.

The slow changes in the habits of Himalayan semi-nomads as cultural landscape changes, is an absorbing study. It is bound to prove useful in any future planning for the advancement of these gay and robust people. A study of the nomadic mind should be taken up by psychologists, anthropologists or by the folklorists to know these people intimately. Geographers should study their socio-economic condition and habitat. The slow changes occurring in the habits of the semi-nomads should be allowed to continue in a natural course. They may be helped to come in close contact with modern cultural developments by improving communications in their habitat, increasing educational facilities, supplying electric power, developing local arts and crafts and finding a market for these products and helping agriculture and horticulture by establishing research farms and model orchards.

## The Siwalik Belt in Kashmir

The Siwalik belt lies in the south-west corner of the State of Jammu and Kashmir. It is a region of forested foot-hills, deeply ravined land covered by scrub jungle and bouldery waste. "With thin and thirsty soils, very much liable to erosion"<sup>1</sup> cultivation is difficult. Forests have been much mutilated. It is an undeveloped region, which has poor communication, and is rather thinly populated except the areas around Jammu and Mirpur.

The belt is limited by the Indo-Pakistan border to its west and south, which runs along the Jhelum from Kohala to Mirpur and then turns to the south-east near Kathua on the Ravi. To the north the limit may be taken as the conspicuous Ranjoti ridge and its rather doubtful extension to the north-west and south-east. Beyond this ridge the altitude increases to the snowy crest of Pir Panjal. Its north-western tip is at Kohala, and the south-eastern tip slightly beyond Jammu. Between these two tips the length of the belt is about 250 kilometres, which is about 60 kilometres wide in the middle. The area of the region is nearly 10,000 square kilometres.

More than one-third of this area is now occupied by Pakistanis. Ever since the partition of India, followed by the intrusion of Pakistanis into the Indian territory, it has remained under constant turmoil. The establishment of the Cease-Fire Line running north from near Jhangar, about 30 kilometres east of the border, brought only temporary relief. The little war between India and Pakistan in 1965 raged through this region, and brought misery to its people.

*Structure* : Almost all this belt is covered by Siwalik deposits, Upper, Middle and Lower, deposited during the

late Tertiary period. They are estuarian and fresh water deposits consisting of parent material brought by rivers descending from nascent Himalaya to the north. The process of their deposition is much similar to what is taking place to-day below the foot-hills of the Himalaya. The only difference is that the Siwalik deposits are older and slightly indurated. They are also involved in the last Himalayan orogeny, when they were folded and faulted. They spread from Kashmir to Assam in a narrow belt south of the Himalaya.

The uppermost and so the youngest Siwalik beds consist of "coarse conglomerates, the boulder conglomerates, or massive beds of sand, grit and brown and red earthy clays. The former occur at the points of emergence of the large rivers—Ravi, Chenab and Jhelum and their chief tributaries, whereas the latter occupy the intervening ground. The clays in the upper part of the series are indistinguishable from the alluvial clays of the Punjab plains into which they pass by an apparently conformable passage upwards."<sup>2</sup> Among these deposits are found the skeletal remains of past fauna which included a variety of elephants, rhinoceros and apes.

The middle Siwaliks lie under the upper strata as massive beds of grey coloured coarse micaceous sand rock with unequal cementation. There are fewer clays and shales.

Below these rocks "the lower Siwaliks are composed, from bottom upwards, of indurated brown sand-stones, intercalated with thick strata of red and purple clays."<sup>3</sup>

"The inner boundary of the Siwaliks is faulted as far as the Chenab, beyond which, the fault gradually gives way to an anticlinal flexure. It is well marked at Udhampur but has lost its significance at Kotli, where the Siwalik outliers are found inside the boundary, in synclinal troughs of the Murrees,"<sup>4</sup> the older deposits lying below the Siwaliks.

The strike of the rocks throughout the region is

remarkably constant in a south-east and north-west direction. The system of strike faults within the Siwalik zone are ordinary dislocations. "Although the Siwalik strata are often highly inclined, specially towards their inner limits, they are never contorted or over-folded, as is the case with the Murrees."

The Murree series outcrop north of the Siwaliks. Near Jhelum they are 40 kilometres wide, but they thin out towards the east to only 6 kilometres near Ravi. The inner limit of the Murrees is a great thrust fault where the older rocks of Pir Panjal ride over them. The upper Murree beds consists of brown sandstones and red and purple shales. The lower Murrees have deep purple and red sandstones at the top and end in conglomeratic beds, which often contain bones of nummulites derived from Eocene rocks underlying them.

The Eocene rocks outcropping as inliers among the Murree beds in this region contain evidences of laterite formation on an old erosional surface, which are sources of iron ore worked for long ages in the past in Punch. There is also much bauxite which can be profitably exploited. At Raisi the overlying coal measures contain seams of anthracite coal upto 7 metres of thickness, which are now being exploited.

"In the valley of Punch near Kotli the base of the Eocene rests on truncated edges of the nearly vertically inclined strata of the Great Limestone,"<sup>5</sup> which rises as the sharp ridge of Ranjoti. "This conspicuous white limestone range, which contrasts strongly with the reddish sandstones and shales of surrounding Murrees"<sup>6</sup> was named as the Great Limestone by Medlicott. It is supposed to be a morine deposit of Permo-Carboniferous age.

*Physiography* : The extension of Punjab plains into Kashmir is not more than 15 kilometres in the south and it narrows down towards the north, till it disappears beyond Mirpur. This portion is badly cut up by ravines. While the most conspicuous feature is the presence of very

broad river beds strewn with boulders. The land slopes upwards to the north, where at places there are red soils. The average altitude is 400 metres.

The belt covered by Siwaliks is slightly higher, ranging upto 1,000 metres. It consists very often, of longitudinal ridges and Dun like valleys. D. N. Wadia thinks that the weathering of "Siwalik rocks in this area has been proceeding at an extra-ordinary rapid rate since their deposition. Gigantic escarpments and dip slopes, broad strike valleys, joined by deep, meandering, transverse streams, give us a quantitative measure of the subaerial waste that has taken place since the Pleistocene."<sup>7</sup> The colour of the lower strata, purple and red is well displayed in contorted and eroded beds along the motor road from Jammu to Udhampur, and also present an absorbing picture from the air. This is specially so in the case of Murrees. "The upper Murrees present aspects of Siwalik type-open broad folds weathered into strike ridges and valleys, with a succession of escarpments and deep slopes, while the lower Murrees show a far greater amount of compression, fracture and dislocation being plicated in a series of tight isoclines and overfolds, with repeated local faulting."<sup>8</sup> Unlike the upper strata the alignment of spurs and ridges has no close relation to the prevalent strike of the country.

There are also broad river terraces formed obviously by successive rejuvenation. They form sites for cultivated fields and villages. Udhampur lies on a broad plain, which is dissected by broad meandering rivers.

De Terra says, "Although dissection is intense, their heights display unmistakable signs of an old topography. Levelled spurs and plateau remnants, valley floors along master streams, indicate a mature relief which underwent rejuvenation."<sup>9</sup>

*Drainage* : In the north the Siwalik belt is drained by the eastern tributaries of Jhelum, below its 150° sharp bend at Domel, below which the river flows southwards

and passes under the Kohala bridge along the Indo-Pakistan border. The ridges and streams in this salient all point towards Domel. South of Kohala the first important stream which runs through the region is Mahal. The next valley southward is that of Gun. Further south is the basin of Punch which is a fairly big river which rises from the slope of Pir Panjal, flows by the town of Punch and Kotli and joins Jhelum, 8 kilometres west of Mirpur. It has a number of tributaries which run into it in longitudinal valleys both from north-west and south-east, such as Rangur and Ban.

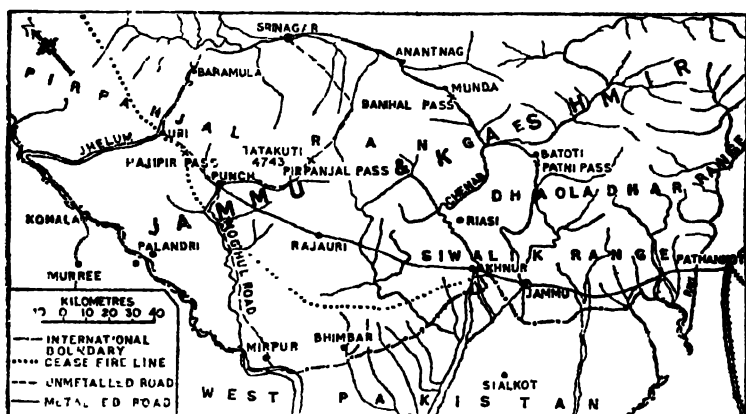
Further east are a number of stream which descend into Jhelum in very broad sandy and pebbly beds, with little water in them, such as Suketar, Bhimbar and Bhandar. Further south is Munnawar Wali Tawi which has a fairly large catchment further north. Its head waters lie on the slope of Pir Panjal, which joins at Rajauri, and cuts through the Ranjoti ridge. Here the river is named Naushahra Tawi, which turns at right angles to east-south-east at Naushahra, forming a longitudinal valley. Another stream called Thande Pani Wali Tawi joins it from the opposite direction and the water of both these rivers turns southwards and adopts the name Munnawar Wali Tawi.

Further east is the broad fan like para-delta of Chenab river with its apex at Akhnur. River Tawi flows below Jammu and enters Pakistan to join the Chenab. Its bed like the other rivers of the region is much overburdened by silt and sand.

*Space Relations* : The Siwalik belt lies as a buffer area between the enchanting vale of Kashmir and the desolate plains of Punjab. People from times immemorial have found out and established routes from the plains to this "heaven on earth." And they had always to go first through this inhospitable wild terrain and then cross the snowy Pir Panjal range to reach their goal. In the time of Moghul Emperors a route was established through the valley of Punch and over Pir Panjal pass 3,491 metres



high. It was frequented by Akbar and Jehangir, who built beautiful gardens and pavilions in and around the lakes of Kashmir. This route was then negotiable by horse-driven carts and palanquins. The British built the motor road from Murree, a hill station in Punjab to Kashmir. The road descends to Kohala bridge, crosses the Jhelum and proceeds up its eastern banks to the Kashmir valley. This road forms partly the Indo-Pakistan border of the region under discussion up to Kohala. A more difficult road was built through this region from Jammu to Srinagar, passing through Udhampur and then going over Pir Panjal at Banihal Pass. Jammu was connected by a branch of broad gauge railway line from Wazirabad, now in Pakistan on the main line from Lahore to Peshawar.



Map 7

Among the three routes mentioned the Moghul route through Punch valley is most difficult as Pir Panjal Pass over which it goes is 659 metres higher than Banihal Pass. The Murree-Kohala-Domel-Uri-Baramula-Srinagar road is the best. After the partition, however, and the intrusion of Pakistanis, it became a war front, which was stabilized at Uri, where the Cease Fire Line crosses it. Post-Independence saw much development in the Jammu-Banihal-Srinagar road. The railway track from Jammu to Wazira-

bad had to be dismantled upto the border, as it went into Pakistan. A new road link was constructed from Jammu to Pathankot, the new rail-head for Kashmir. This link-road passes through the Siwalik belt and has a great strategic importance, as it is now the life-line of Kashmir. It runs very near and parallel to the border and so has great military importance. It is, however, vulnerable to sudden attacks by Pakistanis. A second road between Pathankot and Udhampur, further away from the border has been proposed. It has also been proposed to extend the railway from Pathankot to Udhampur. These new routes when completed will bring prosperity to this part of the Siwalik belt.

The Jammu-Banihal-Srinagar road is the chief transport artery at present. So it has been broadened, painted with tar, and its gradient and curves have been made gentler. Further, a low-level double road tunnel, named Jawahar Tunnel, has been pierced through Pir Panjal 600 metres below Banihal Pass to make this road safe from winter snow. The road from Jammu to Punch, which was in bad disrepair has suddenly gained much importance, as a strategic road.

The Cease-Fire-Line bulges towards Gulnarg near this point. The bulge was used as a salient by Pakistanis for infiltration into the valley. By capturing the Uri-Punch track and Haji Pir Pass, the bulge was cut off from Pakistanis. But this strategic position had to be returned back to Pakistanis after the Tashkent pact.

*Cultural Landscape :* The city of Jammu is the focus of the south-eastern half of the Siwalik belt. It has been built on a hill north of the river Tawi, and guards the bridge over it. Its crest is defended by a stone wall. Thus the city has an important strategic location enhanced by the fact, that it is now the chief gate-way to the vale of Kashmir.

Jammu is the winter capital of the State, and many Government offices are situated here. Thus it is also an administrative city. It is the centre of Dogra culture and

there are many large temples here. Back in the mountains is the famous shrine of Naina Devi. So Jammu is also a religious city.

The plains below Jammu and the flat valley of Tawi behind the hill give a good agricultural produce, specially rabi crops such as wheat and gram. Millets, peas, rape and pulses are also grown. All this produce is brought to the grain market of Jammu. Besides goods from the plains of India and mountain produce from the vale of Kashmir including its fruit, nuts and handicrafts come to the markets of Jammu. So it is also a commercial town of great importance, being situated at the junction of two types of regions. It is also a good educational centre.

While the density of population in the district of Jammu is about 130 per sq. kilometre, it is 95 per sq. kilometre in Mirpur district. Here there are two small border towns of Bhimber and Mirpur. Their considerable Hindu and Sikh population had to shift to areas on the Indian side of the Cease-Fire-Line. Cultivation in this district is wheat, barley and mustard seed during winter and bajra, jawar and maize during summer.

Mirpur lies in a small basin of river Khad which is very badly ravined. Khad falls in river Punch just above the point where it joins the Jhelum. Ten kilometres below the confluence is Mangla headworks of the upper Jhelum canal. This point and a small portion of the canal lies in the Indian territory which is at present under the control of Pakistan.

Bhimbar is situated in a similar small river basin of the same name. The town is located at the edge of a small plain, largely a bouldary waste, and a ravined upland to the north.

Above Mangla the Jhelum flows through a gorge, and below this point, it fans out into a broad braided course.

North of Mirpur the lower portion of the Punch valley is also a ravined waste land, sparsely populated. In its centre is village of Chaumukh.

Naushahra is situated in the middle of a longitudinal valley in which flow Naushahra Tawi, Thande Pani Wali Tawi and Jambhir. It is now an important point on the strategic Jammu-Punch road.

Riasi is situated on a wide terrace on the eastern bank of river Chenab. There is much development in and around Riasi, where coal mines are being worked out. The occurrence of good quantities of bauxite and iron ore may further enhance its importance. In the hilly slopes around Riasi and Naushahra, irrigation from hill streams is available, and here maize becomes more important than bajra.

Kotli is another river junction town, where two strike valleys join river Punch. The country becomes more and more wild further north towards Palandri and Bagh, where the area is much more hilly and inaccessible. There are no good roads in this portion. Only tracks wind up and down the rugged terrain, till we reach Kohala bridge, where the river is hemmed in by steep hills on all sides.

### Notes

1. Spate, O. H. K. :—India and Pakistan.
2. Gansser, A :—Geology of the Himalayas.
3. *ibid.*
4. *ibid.*
5. *ibid.*
6. Wadia, D. N. :—Geology of India.
7. *ibid.*
8. Spate, *op. cit.*
9. De Terra, H. :—Observations on the upper Siwalik formation and later Pleistocene deposits in India, *Proc. American Phil. Soc.*, 76 (6)

## Morpho-Ecology in Pir-Panjal

Geomorphology in the Himalaya plays a very important part in moulding human activities. It is more so in steep and rugged landscapes, where river terraces, alluvium filled basins and the degree of slope together with altitude determine land use. They control the pattern of routes and the flow and intermixture of culture. The term "morpho-ecology" has been coined to denote this relationship between landform and man's adaptation to it.

Among the smaller ranges running parallel to the main Himalayan range, south of it, in the western Himalaya, Pir Panjal and Dhaola Dhar are the most conspicuous. Their crests are more or less covered by perpetual snow, and are seen stretching from east to west as a dazzling array of silvery peaks from the plains of Punjab. D. N. Wadia rightly refers to Pir Panjal as the most dominant feature in the geography of the region.<sup>1</sup> The view of this mighty range from Patni Pass (2,027 metres) between Kud and Batoti, across Dhaola Dhar, on the road to Kashmir from Jammu, reveals its magnitude. Another grand view of Pir Panjal is obtained from Koti Rest House<sup>2</sup> in Kulu.

According to Burrard and Hayden<sup>3</sup>, however, it continues more or less obscurely as a geographic feature as far as Sutlej, where it fuses with the northern flank of Dhaola Dhar. But this statement is not quite correct and Deo Tibba is clearly its eastern extremity.

The range is cut through by deep gorges at two places; by the Jhelum below Baramula and by Chenab below Kishtwar. The height of the range increases towards the east, the highest peak being Deo Tibba in the eastern extremity. In Lahul there are four peaks above 6,000

metres. The Kishtwar gorge is in the middle of the range. The altitude of the river bed here is about 1,000 metres, while the range rises over 3,000 metres on both sides of it to Naginsheru (40,89 m) in the east and Piparan (4,041 m) in the west. In Lahul passes are very high and difficult. The lowest pass is Rohtang (3,179 m), which is closed to traffic in winter, when blizzards rage through it.

In the western half of the range there are no peaks above 5,000 metres. The highest peak is Tatakuti (4,742 m) and the next is Brahma Sakli (4,705 m). The most easily accessible peak is Apharwat (4,143 m), just above Gulmarg. The lowest pass in the range, Banihal (2,832 m) is situated west of Brahma Sakli. The old Jammu-Srinagar road passed across it, though at present it crosses the range at a lower level (2,300 m) through the two kilometre long double Jawahar Tunnel. Another very good motor road comes from Rawalpindi and Murree in Pakistan. The old Mughal road is now only a mule track.

Structurally Pir Panjal range, "is a highly individualized unit, as conspicuous by reason of its great topographic distinction as by its marked difference of geological constitution."<sup>4</sup> In fact the trend of the range at its western extremity is better understood by 'a study of its structure.

Before the monumental work of D. N. Wadia on western Pir Panjal, Lydekker<sup>5</sup> and Medlicott<sup>6</sup> recognised the uniqueness of Pir Panjal structure, but presented a very much generalised picture of it. They considered the south-western half of Pir Panjal as composed of one monotonous, indifferentiated 'metamorphic series of slates' and traps (the Panjal system), with a narrow strip of unfossiliferous sediments of Carbo-Trias age (the Kuling and Supra-Kuling series) along its border. They have a thick core of gneissic rocks."<sup>7</sup>

Another feature of the Pir Panjal is its gabbro bosses which protrude through the central axial zone of the range between Tosha Maidan and Rupri near Tatakuti

peak. The bosses are associated with a group of sills, mainly dolerite, penetrating along the bedding planes of agglomeratic slates into which the gabbro bosses intrude. "Two such sills, each over 100 feet in thickness, composed of a pale-green, coarse dolerite, pursue a serpentine course for a few hundred yards through jet black agglomeratic slate precipices, which crown the slopes facing Poshiana just south of the Panjal Pass. The striking colour difference of the invading sill and its winding outline among the inky blank country-rocks justifies the name of the hill Sarpi Sangur or hill of petrified snakes. A group of thick dolerite sills is observed in the high precipitous scarps at the foot of Tata Kuti. Bosses and sills of a similar nature are again observed north of Nurpur Pass."<sup>8</sup>

Gneissic intrusives are not so frequent as gabbros. "The main intrusion of gneiss is typically exposed in the high Kopra Hill Pass (3,191 m) about 8 miles south-west of Apharwat which shoots out prominently from amidst the surrounding dark-grey softer slates with abrupt white granitic precipices rising nearly 300 metres. A series of remarkably continuous veins of quartz surround the main mass of the hill in all directions,"<sup>9</sup> and at place they become remarkably topographic features as near Danna where the vein appears as 10 metres thick dyke crossing the deep defile of river Mandi, which drains the southern slopes of Pir Panjal, south of Apharwat.

The Dogra slates produce gigantic cliffs in the Chang gorge south of Tatakuti and Betar valley north of Punch. These gorges are carved through slates, which at some spots appear to have better cleavages so as to produce material for roofing and building.

The central axis of Pir Panjal is almost wholly "built by agglomeratic slates and tuffs in conjunction with Panjal traps. That part of the jagged and serrated crest, which extends between Nurpur and Rupri Passes in a line of pinnacles and peaks including Tatakuti, is composed of tuffs and slates, permeated with dolerite sills."<sup>10</sup> North

of Nurpur up to near Gulmarg the Panjal traps form the crest.

The cluster of elevated peaks around Tatakuti, formed of stooty black agglomeratic tuffs and slate have jagged splintered tops due to frost shattering. Stupendous bare cliffs drop from 1,000 to 2,000 metres south of the summit. Below the cliffs are large accumulations of morainic debris and boulder clay. The spurs here, around the Lungni Chasm south of Tatakuti are hog-backed and ice-planed, which support a number of high pasture grounds, such as Banota and Paspathri, where Gujars roam with their flocks.

Though there are no glaciers of appreciable size in Pir Panjal today, it is quite clear from the topography that glacial denudation occurred on both sides of the crest up to 2,500 metres elevation, and the land forms obtained here are distinct from the subaerially sculptured ranges of lower elevation. Glacial features are also observed at Haji Pir and Ganga Choti. Here we not only meet huge and widely spread deposits of moraine, but also hummocky, moutonneed crests covered by grassy and flowery turf, amphitheatres in the sides of hills and U-shaped valleys into which deep cascades of water fall from hanging valleys, such as in the Betar valley south of Haji Pir, and further west, is the well known Nurichhan falls near Baramgala south of Pir Panjal Pass.

“Of the valleys of Pir Panjal the Girjan valley running in a wide longitudinal basin along the strike, south of Pir Panjal Pass is specially remarkable for its glacial features.”<sup>11</sup> It has a perfect U-shape, with high valleys dropping in from both sides. At its head near Rupri on both sides of the crest there are numerous cirques and about 20 glacial lakes or tarns. The biggest of them in Bhag Sar nearly two kilometres long. The slopes in this area are covered by a series of extensive pastures and vivid green meadows.

The topography of the north-eastern slopes of Pir Panjal



gradually falling down to the level of the vale of Kashmir, is markedly different from that towards the south. The main features of the northern slopes is the making of the solid geology by glacial debris and moraines. This has made the slopes gentle and reduced the ruggedness. There are broad slowly descending fields strewn with boulders. *Pinus longifolia* are absent and deodars appear below the tree line. Springs ooze out from the loose material all over the area. Grassy meadows and abundant spring water allows for an ideal habitat of Gujars and their flocks of sheep and cattle. There are hundreds of kilometres of rolling moraine covered slopes overgrown by meadows. These are the "Margs" of Kashmir. They are practically all over the area between the tree line and the snow line. Above 4,000 metres, tongues of corrie glaciers cling to the steeper slopes below the crest, descending down in winter and contracting and even disappearing during summer, leaving their paths exposed, which look like rivers of boulders descending down the slopes. One meets such features on both sides of the crest. Two such bouldery paths are found on both sides of Apharwat.

Below the tree line patches of Margs appear between dense deodar forests, of which Gulmarg is famous for its velvety green meadow surrounded by tall dark green deodars, and backed by the snowy crest of Pir Panjal. The meadow has an excellent golf course.

The origin of the current landscape is better understood by Tertiary and recent geological movements. During the Pleistocene, according to de Terra and Teilhard de Chardin<sup>12</sup>, there were four distinct glacial phases and two or more uplifts of the Pir-Panjal range, which gradually rose to its present huge dimensions.

During a later rise the Karewa beds were also lifted up along the flanks of Pir Panjal, but were subsequently covered by glacial debris.<sup>13</sup> The huge moraine deposits sometimes end in bluffs, below which appear the Karewa beds.

The slopes of Brahma Sakli and Parasing are covered by a large number of corrie glaciers, below which appear broad open meadows drained by Zajinar and its tributaries. The meadows spread north-westwards to Kharmarg, Buddh Angan, Tosha Maidan and lastly Khilanmarg above Gulmarg. Easy accessibility of Gulmarg has made it a tourists paradise. The motor road from Tanmarg has been extended to it, and a passenger rope trolly is being erected to connect it with Khilanmarg, whose gradually sloping meadow has provided an ideal place for winter sports. A Ski club also is located here.

On the southern side of Pir Panjal the topography is much more rugged. The motor road to Srinagar descends steeply from Patni into the Chenab gorge, zigzagging down argillaceous rocks, which more than often obliterate the road by huge landslides, which have increased in number and volume as deforestation of pine forests (*Pinus longifolia*) has continued unchecked.

Above Banihal town the upper reaches of Bichhlari river, a tributary of Chenab, spread out in a broad amphitheatre surrounded by craggy frost-shattered bare rocks along the main crest and its spurs. The basin is also divided into sections by sharp edged spurs descending from the high ridges. The location of Banihal town is due to cultivable slopes surrounding it.

South of the main Pir Panjal range there are a number of parallel strike ridges. Of these, Ranjoti ridge south of Punch made of limestone and dolomite, rising as an inlier from soft sandstones, is most prominent. This is the "Great limestone" of Medlicott, which attracted the attention of the Geological Survey of India because of its association with Eocene coal and was investigated by Medlicott in 1870 and later on by Wright<sup>14</sup>. The ridge forms "a very striking topographic feature, both from the abruptness of its relief and from the much worn serrated aspect of the steep limestone and dolomite crags arising through soft tertiary sandstones. It is crossed by a number of streams both

transverse and lateral, which have cut out deep craggy canyon-shaped defiles, at places barely 20 metres in width, but with bare vertical precipices some hundreds of metres in height.”<sup>15</sup> The limestone inlier appears again near Riasi and passes across river Chenab, producing a deep gorge. At Tahi south of Punch, a thermal sulphurous spring named Tatta Pani issues from limestones. The volume of water is large and it is clear and limpid with a temperature 80°C. Minor quantities of sulphur are deposited near the spring.

Springs also issue from gravelly alluvium covering rocks which supply water through fissures communicating with surrounding hills. Punch town stands on one such gravelly terrace, from which voluminous springs of fresh water pour out supplying all the water needed by the town.

While deodars grow on the high portions of the crest of Ranjoti ridge, pines are found lower down. Further down wild pomegranates grow in groves. Their sour seeds are used as condiment. Near Kud on the Jammu-Srinagar road, pomegranates grow profusely.

The most remarkable topographic feature in the central part of Pir Panjal is the great transverse gorge of Chenab below Kishtwar. This town is situated on a flat terrace 8 km by 3 km, about 300 metres above the gorge. It is an island of prosperity set in the middle of a scene of wild grandeur.

Terraces are also very prominent throughout this part of the river Chenab, which have led to the growth of chains of big villages, such as Doda, Babhor, Jadhpur, Jatheli, Dirhot, Mandi and Barhut on the northern bank and Khateni, Thalela, Mangala, Diron, Hiran and Jangalwar on the south bank. A motor road passes over the southern terrace, and connects with India-Kashmir road at Batoti, going up to Jangalwar, and further as a track to Kishtwar. An important track also skirts the northern bank terrace. The terraces are two to three

kilometres wide and end in steep scarp faces on both sides of the Chenab gorge.

River Neru joins the Chenab from the south at Doda. Terraces continue along it at the same level as those on the Chenab. But as the Thalweg level of Neru is higher, the terraces are not flanked by scarp faces. The river water is easily obtained for various uses by the villagers living in the valley. A motor road bifurcates from opposite Doda and goes to Bhadarwah over the terrace along the valley. Bhadarwah is situated in another bowl-like amphitheatre drained by the headwaters of Neru. Features similar to Neru valley are met with in the Marau valley, north of Kishtwar. The Thalweg widens out here and there, where alluvium filled flat basins appear, resulting in prosperous villages. An example is the Cul-de-sac of Lopor and Janatpor, adjoining and extending towards Sondar. Isolation is the keynote of the happy people living in it. They have, of necessity to be self sufficient, but they live "far from the madding crowd" of the modern civilization.

East of Naginsheru peak towering above the Kishtwar plain, Pir Panjal range attains a greater height and gradually rises to a number of peaks above 6,000 metres. The range is covered by perpetual snow and corrie glaciers cling to its slopes, specially on the northern flanks, which is generally in shadow. In fact throughout the range, there is more snow on the north-eastern slopes, where it stays for a longer period after winter. It starts melting in April on the sun drenched southern slopes, but stays, on the northern slopes till the end of May. Small avalanches thunder down as the bases of snow patches get loose after melting, and are a source of danger, specially to traffic on the road near Banihal. Only goat tracks cross over seasonally accessible passes. Pir Panjal, which may be taken as a great cultural divide between the regions to its north and south is more so here. To its north are the valleys of Pangi and Lahul, where the social structure, religion and customs are markedly different from those

prevalent in the south. The average level of these valleys is between 3,000 and 4,000 metres. Cultivation is sparse. Barley is the only grain grown. Wheat and maize can grow in lower valley bottoms only. "Kuth" a kind of root crop is extensively grown as a cash crop. The root has medicinal values, and is exported to the Far East. Its cultivation is extending in the region. High pastures are suited to sheep rearing. Summer pastures are located on huge fluvio-glacial fans over which some grass grows. They are called "Thaches." The majority of the inhabitants are Buddhists and follow "Lamaism". Lahulis are polyandrous. Only a few trees grow in sheltered valleys. The weather is usually dry, cold and windy. Perhaps the drought is gradually increasing. A shrinkage of glaciers is very much evident. This was observed in the Gangstang glacier<sup>16</sup> north of Keylang.

The southern slopes of Pir Panjal in its eastern portion contain a number of closed basins. One of them is the basin of river Siul. In the north and east it is closed by snowy peaks and the steep rocky crest of Pir Panjal, and in the south and west by two of its spurs. Population and paths follow the stream courses, and the focus is at Tisa, a big village located at the junction of three streams. Being nearly completely isolated, the valley has developed a distinctive culture. This may be said of the whole of the district of Chamba, which is drained by the Ravi.

The town of Chamba is situated on a broad, flat terrace. On the opposite bank also there are extensive terraces on two distinct levels, providing good cultivable rice lands. So the supply of food and water is assured.

The upper reaches of the Ravi consist of a high snow covered area, called Bara Bangahal. A number of medium sized glaciers feed the headwaters of Ravi. Some of them are more than 10 kilometres long, such as the Shah glacier. Gaddi nomads roam the high pastures below the snow line. The only village in this snowy waste is Bara Bangahal at the exit of this cul-de-sac, where Kalihen stream pierces

the ring of snowy peaks and proceeds down towards Chamba.

In Kulu, the upper Beas valley comes down below 1,500 metres below Manali, below which flat terraces have developed extensively, providing space for horticulture (specially apples) and rice fields. Higher up are maize fields,<sup>17</sup> followed by dense deodar forests.

Morpho-ecology of Pir Panjal and its flanks is of absorbing interest, and the above discussion illustrates how strongly the physical environment influences man in this region.

## Vale of Kashmir

The oval shaped vale of Kashmir lies between the main Himalayan range and the Pir Panjal range in the State of Jammu & Kashmir covering some 4,500 sq. kilometres, the longer axis trending NW-SE parallel to the two ranges mentioned.

### The Karewas

We have already discussed this in the chapter of Geology and Structure. Here are some more details when we remember A. L. Coulson<sup>1</sup> who has admirably summarized the work of various geologists on this subject up to 1937 in a paper on Pleistocene Glaciation in north-western India. He has stated and criticised the views of H. B. Medlicott, C. S. Middlemiss, R. D. Oldham, H. de Terra, B. Sahni, D. N. Wadia and others.

According to de Terra and Teilhard de Chardin<sup>2</sup> there were four distinct glacial phases interrupted by three longer interglacial phases during the Pleistocene. Also in this interval there were two or more uplifts of Pir Panjal range. At the beginning of Pleistocene a slight rise in the range that was the precursor of the Pir Panjal, an obstruction was caused near Baramula resulting in the creation of Karewa lake. Subsequently, in general, the lake bed became deeper, while the flanking ranges rose higher, and from them fluvial, fluvio-glacial and morainic materials were deposited in the lake bed for nearly the whole of Lower and Middle Pleistocene. The nature of this deposit varied according to the change in climate and the rise of Pir Panjal. The lake level also fluctuated accordingly and was further controlled by the erosion at the outlet near Baramula.

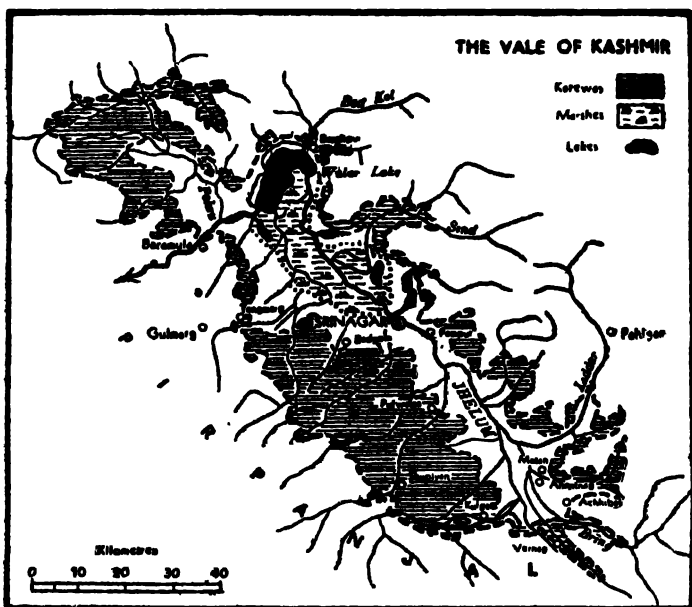
Karewa beds have a total thickness exceeding 2,200 metres,<sup>3</sup> but it is difficult to estimate the exact thickness, due to folding and unequal erosion. The lowermost Karewas were perhaps laid near the end of Pleistocene, when the first glacial phase set in and a slight upheaval of Pir Panjal created the lake. Throughout the first interglacial period during Lower Pleistocene the Lower Karewa beds were deposited. They are fluvio-glacial in nature in general. The lake drained off after this for a small period when the Lower Karewas were denuded about 700 metres from the tops of two flat anticlines.<sup>4</sup> The lake formed and deepened again as the second glacial phase set in, and the Upper Karewas were laid over the Lower Karewas, with an unconformity in between. This deposition continued during the second interglacial phase in Middle Pleistocene. In Upper Pleistocene a third glacial phase set in, while the lake was gradually drained off. In the last stages forests appeared over portions of the valley, which are today preserved as interstratified beds of thin but extensive seams of lignite which are in workable proportion in some localities in Hundawar tehsil.

The final draining of the lake was perhaps caused by the cutting back by river Jhelum through the obstruction near Baramula and capturing the Upper valley, which at that time was part of Chenab basin.

In the post-Karewa period the Pir Panjal rose nearly 2,000 metres, while the lake had disappeared. The Karewa beds were partly involved in this orogenesis. They were slightly folded and tilted in some places, specially near the base of the Pir Panjal where at some places they dip 40°. The dip is generally towards the valley. Portions of the Karewas were lifted even up to 4,000 metres.<sup>5</sup> A small portion of Karewas was located by Coulson at Linyan at an altitude of 3,100 metres near Gulmarg. Fluctuating ice ages produced boulder beds and moraines which lie embedded in the Karewas. The fourth glacial age spread tongues of glacial moraines over them.



Subsequent erosion is now gradually removing the Karewas from the valley. But nearly half of the valley is still covered by them. The present Wular and other lakes such as Manasbal and Dal, and many other marshy areas such as Anchar are not the remnants of the past Karewa lake,<sup>6</sup> for the top beds of Karewas which were at the bottom of the Karewa lake now lie much above the lower valley. The present lakes are, in all probability, caused by a slight, very recent, rise of the Pir Panjal, causing a slight obstruction near Baramulla. In all probability the present lakes were all joined together and consisted of a single sheet of water not long ago.<sup>7</sup> A slight lowering of the outlet at Baramulla has caused them to disintegrate.



The erosion features at the edges of Karewa platforms also suggest a slight rise in the recent times as the streams flowing through them cut deep gorges near the eroded edges which stand abruptly as scarps, while the top of the Karewa, they flow gently over slightly undulating country.

The gorges of Ningal Nala<sup>8</sup> and Ferozpur Nala on the two sides of Gulmarg are good examples to illustrate this point. The scarp-like face of the Karewa facing the road between Bhawan (Matan) and Pahlgam and gorges opening out on its sides are further proof of this phenomena.

The best view of Karewa topography is obtained from spurs of adjoining hills. The Karewa of Martand above Bhawan (Matan) can be viewed from a small temple on a spur to the west.

The broadest spread of Karewas borders the Pir Panjal, but narrow belts occur along the northern edge also. They provide alignments for roads, which avoid the valley bottom liable to flood. The road from Shadipur, skirting Manasbal lake and proceeding towards Bandipur passes over such a narrow belt. At places the Karewa belt penetrate valley bottoms between spurs and from little flat valleys unrounded by hills, such as the Lolab valley east of Wular lake. An arm of the past Karewa lake penetrated the hills here.

The bigger rivers like Liddar, Bring, Sind, Bod Kol and Pohru have cut deep in the Karewas and have washed away all the Karewa material very often right up to the edge of the mountains, and separated the Karewa flats into blocks.

*Land use of Karewa tops :* Usually the Karewa tops are dry and are covered by scrub jungle, but Kashmiris have evolved a method of irrigation suited to topography. Small rivulets descending down from the adjoining mountains are artificially distributed to a number of channels expanding out like a delta and irrigating the land. The channels are called 'Kuls'. With great ingenuity they are taken to various levels to irrigate terraced fields.<sup>9</sup>

The dry aspect of the Karewa tops also encourages tree culture. Almonds specially flourish in bouldery soils in higher portions. In damp situations lower down, willows are grown to supply twigs for wicker work. Peaches,

plums, apricots and apple gardens are located on sloping grounds where grain cultivation is not possible.

The Karewa of Ferozpur near Tangmarg presents a pleasant aspect of green fields, gardens and rows of willows, poplars and other trees. Here the irrigation channels are taken out from Ferozpur. Nala descending from the snow covered range above Gulmarg. They are broken into a number of levels and supply copious irrigation water to the fields and gardens.

As compared to the Ferozpur Karewa, the Karewa of Martand above Bhawan (Matan) appears as a vast open field presenting a scarp face towards the Liddar river flowing below it. But the water of Liddar is caught higher up near Pahlgam and brought by a canal to its surface. The canal here breaks into a number of branches and irrigates the Karewa. Past prosperity of this Karewa is reflected in the occurrence of ruins of the massive temple of the Sun built by king Lalitaditya in the 8th century.

Mention may also be made of detached mounds of Karewas near Pampur which are famous for their saffron fields<sup>10</sup>. The flat top here has been further eroded to undulating mounds. The saffron fields are very carefully prepared. The plant, an autumnal Crocus, grows out of a bulb which is planted in specially prepared beds in rows, which are properly spaced. Every year the bulbs sprout in early autumn and are in full bloom on the full moon of October. The delicate orange coloured stigmas of flower, carefully plucked and dried, constitute the article which is widely used for clouring and flavouring confectionery and Kashmiri dishes. Saffron can however, be easily adulterated by mixing it with artificially coloured grass. The soils of this Karewa is said to be specially suited to the cultivation of saffron<sup>11</sup>.

*The Valley Bottom :* Jhelum and its tributaries have gradually removed the Karewas completely from nearly half of the vale of Kashmir. The rivers flowing in this portion have their base level of erosion in the Wular

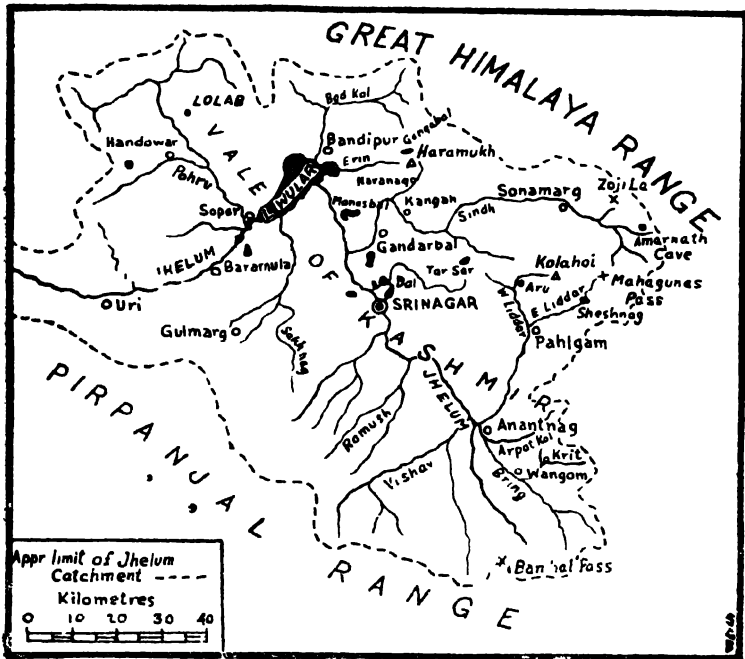
lake. Also they are overburdened by huge amounts of silt, pebbles, sand etc., brought from the high mountains where they run as torrents through steep gorges, where frost action is very much pronounced. They also bring down eroded material from the Karewa beds. Their beds in the valley bottom are therefore filled up with sediment. The rivers are shallow and run in braided courses. They meander leisurely on a flat terrain and easily flood the low valley surface after a storm.

It is further quite probable that the outlet at Baramula is not sufficiently deep to allow incoming water to drain out quickly. The result is the creation of Wular and many other lakes as well as large marshy tracts which are inundated periodically. Nearly half of the lower portion of the valley bottom in the north-west is marshy. However the double process of the erosion of the obstruction at Baramula and silting of the lakes may gradually reduce their size. A large tract of new land is emerging in this manner near Bandipur. Kashmiris living in this "low land" have adapted their life to this watery environment. A considerable number of them actually live on water in a variety of boats. The river and canals provide a very important means of transport. Leaving out the luxurious house boats, which are miniature floating places for entertaining tourists, there are great variety of boats. The most mobile among them is the *Shikara*. The *Dungha* boat is a utility craft of medium size, and very often forms a complete house with two or three small bedrooms and a kitchen for a family. Big sturdy load carrying boats carry sand, bricks, stones etc., up and down the Jelum.

The river and the lakes abound in fish. The Government has also opened a number of pisciculture centres, such as those at Harwan and Achibal, from where trout and other types of valuable fishes are being distributed in various rivers of the valley. Spearing of fish in the crystal clear water of Manasbal lake by scores of villagers every morning is interesting to watch. Fishermen live in tempo-

rary huts and boats in the marshes surrounding Wular lake. They catch fish in large quantities and dry them.

Water chestnuts grow in Wular lake and are picked by Kashmiris and eaten fresh or baked. The water also yields lotus stalks, which are very much delicious. Round about Srinagar there are many "floating gardens" made up of earth mixed with twigs, roots etc. They also grow excellent vegetables.



Map 9

A feature of the present landscape is planting of rows of willow and mulberry trees along the roads, besides the graceful poplars, which have lined Kashmir roads in the past as well as present. Willow sticks for wicker work and mulberry leaves for sericulture add to the utility of road side trees. Beside yielding an excellent nutritious nut, much in demand throughout India, it provides fine-grained wood which is carved into exquisite designs by Kashmiri

craftsmen. The "Chinar" is a common shade tree in gardens and roads. Its star like leaves appear in Kashmiri art goods, in embroidery, wood carving and silver ware, and it may well be called the national tree of Kashmir.

The rythm of life in the valley is, however, very much controlled by the seasons. The advent of spring means the melting of snows in the valley and sprouting of leaves and blooming of flowers in a riot of colours. Paddy is sown in the well terraced fields and low lands. On high banks of soil maize flourishes. In the fruit orchards apples and pea trees are clothed with white and pink flowers.

There is a great influx of tourists in the valley, and Kashmiris are busy earning money by catering to their needs in a variety of ways. Kashmiri art goods—embroidery, shawls, silks, furs, papier mache goods, walnut furniture, carved art goods, wicker work, jewellery made from imported and local stones, silverware, etc. are sold by clever salesmen to them.

As winter approaches in October and November the tourists leave the valley and Kashmiris get busy in domestic affairs. They spend the money earned in festivals and marriages. But soon the craftsmen get busy in preparing art goods. There is no agricultural activity, and the famed cottage industry of Kashmir flourishes indoors. The art goods produced are stocked for sale in the coming year.

The usual dress of Kashmiris in winter is a loose cloak of wool. The body, however, is kept warm by a charcoal fire in a small earthen pot fitted in a wicker case and kept in touch with the bare skin near the bosom. This contraption called "Kangri". It leaves a black burnt mark on the skin. The Kashmiri heaves a sigh of relief as spring comes once again and snow starts melting.

A striking geographical feature of the valley is the large number of springs found skirting the valley fringe. A spring line can almost be drawn by joining them up. The springs generally ooze out from below Triassic limestones

and dolomites. "A thick series of compact blue limestones, slates and dolomites is conspicuously displayed in many of the hills bordering the valley to the north. They compose a very picturesque feature of the landscape, noticeable by light coloration of their outcrops and their graceful long and undulating folds, which bring them out in strong relief against the dark colored craggy lavas and slates of the underlying Panjals. Numerous springs of fresh water issue from the cliffs and prominences of these limestones and form the sources of the Jhelum. The best known of these are the river-like springs of Vernag and Achhibal and the multitudinous springs of Anantnag and Bhawani"<sup>12</sup>.

The springs were made good use of by the Mughal Emperors, specially Jehangir. Gardens and fountains were built below them. The gardens below Chashma Shahi or the "Royal Spring" near Srinagar, Achhibal and Vernag are famous for their beauty. The springs also became centres of religion, as at Anantnag and Matan. The towns here grew around the springs and the associated temples. The size of these springs is noteworthy. They must be outlets of underground tunnels of water borrowed in the limestones. The water is supplied by melting snows on the ranges above.

The caves of Matan and Aish Maqam are also examples of limestone topography. The cave at Matar is a dried up tunnel a few hundred metres long. It breaks into a number of branches just like the tributaries of an underground river.

In areas where moraines cover the limestones, the springs come out from many points in the morains.

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## The Northern Valleys of Kashmir

The heart of the mountain State of Jammu and Kashmir is the northernmost State of India. Through it passes at least eight snow covered ranges, diagonally, from north-west to south-east, namely Aghil, Karakoram, Kailash, Ladakh, Zaskar, Himalaya (central axis), Pir Panjal and Dhaola Dhar. But the heart of the State lies in the enchanting Vale of Kashmir, an oval shaped flat bottomed valley, at a height of about 1,500 metres, once the bed of a lake (Karewa lake), and now drained by river Jhelum and its tributaries, which are busy in washing away the Karewa beds deposited in the part lake, whose remnants make a ring of low plateaus round the valley.<sup>1</sup>

To the south of the Vale rises the Pir Panjal, whose present landscape is better understood by tertiary and recent geological movements. During the Pleistocene, according to de Terra and Teilhard de Chardin<sup>2</sup>, there were four distinct glacial phases and two or more uplifts of the Pir Panjal range, and this we have already mentioned in the previous chapters. Their broad and gentle slopes covered by moraines and slightly uplifted lacustrine Karewa beds, spreading from below the crest, and ending in bluffs above the valley, are the main features of the topography of the range<sup>3</sup>. A study of the geomorphology of these valleys, noted for their grandeur, and the people living in them is, therefore, fascinating.

The two main valleys ascending up, northwards from the Vale of Kashmir to the gigantic snow ramparts of the Central Himalayan axis are those of Sind and Liddar. The later, further divides into East Liddar and West Liddar valley, beyond Anantnag, are Arpat Kol and

Bring, which send their tributaries upto the crest of a great north-south spur of the Himalaya, descending southwards from near Amarnath cave to Kun Gali (pass), near which it joins the Pir Panjal.

In the western part of the Vale of Kashmir, the streams descending into the Wular depression, do not drain the southern face of central Himalaya, but an intervening range separating them from the valley of Kishen Ganga, which flows longitudinally between it and the Himalayan axis, through the beautiful terraces of Gurais, formed by fluvio-glacial deposits brought down by this river and its northern tributary named Burzil. These streams are Erin, Bod Kol, Shat and Shulur, none of them exceeding 40 kilometres. Among the streams which join the Wular lake from the west, the most important is Pyhru, a major part of which valley was drowned by the Karewa lake, and to-day forms part of the Vale of Kashmir<sup>4</sup>.

*The Twin Valleys of Liddar :* Coming to the larger northern valleys, the twin streams of Liddar are the most important, specially from the human points of view. At their junction at Liddar is located the triangular basin of Pahlgam. The occurrence of a triangular piece of flat land at the accordant junction of two valleys of equal erosive strength, in high Himalayan, is a frequent landform type. It is not found near a discordant junction, where a hanging valley joins the main valley, by tumbling into it. It is due to the fact that there is tremendous amount of eroded material, produced by frost action in the higher reaches of these rivers above the snow line.

The triangle of Pahlgam has a base of three kilometres, and two sides of five kilometres. It provides ample space for the bazar ( market centre ), hotels, bungalows and an ample camping ground for tourists throughout the summer, and for thousands of pilgrims to Amarnath cave during August every year, for whom Pahlgam is a starting point. The rivers also provide trout fishing.

A very good example of the formation of a similar triangular piece of land is obtained in Zaskar, where rivers Doda and Kutchil Demda join to form river Zaskar at Padam, 3,600 metres above sea level.

The altitude of Pahlgam is about 2,100 metres, which is nearly as much as that of Khiraon Ganga-Alakananda junction below Hanuman Chatti. But in both these cases the heavily glaciated and frost shattered snowy peaks and glacier snouts are not far away. Hence there is abundant supply of eroded material. At both the places snow ranges and peaks are visible in all direction, quite near.

The high Alpine meadows near the tree line or 'margs' are not far above. The marg of Baisaran is reached by going up above five kilometres to the east. It is surrounded by stately deodars just below the tree line. Such meadows are haunts of nomadic Gujars, whose summer dwellings are found near the tree line.

Just above and below Zajpal there are two conspicuous breaks in the Thalweg of Liddar. The lower one appears just above Pissue Ghati where the transverse section of the valley changes from an open to a closed type. The other appears above Zajpal. These breaks emphasize the glaciated nature of the Liddar valley, being longitudinal rock steps. Some elongated rock-basin type lakes are also found in the upper course of a hanging valley joining from the south. The valley drops very steeply from corrie glaciers on the sides of a 6,500 metres high water-shed, to below 4,000 metres in Liddar.

Further up is the basis of Sheshnag lake which is fed, by snow-melt water from corrie glaciers and ice-fields to the east and south. The upper Liddar also drops into the lake and flows out over a moraine plug. Along the northern rim of the lake there is a broad terrace called Wavjan, which is used as a camping ground like Zajpal. The terrace is made up of glacial till. It is thus, a terminal moraine of an ancient glacial snout. Similar features are found at many other places in the Himalaya,

as for example at Basudhara across Alakananda, two kilometres away from the Satopanth Bhagirath snout, and across Rishi Ganga valley above Badrinath.

Above Sheshnag, which is often frozen partly in summer, the Liddar is often buried under snow. Further up to the east is a huge amphitheatre, backed by polished walls of bare crags, showing a remarkable array of folded rocks, ending in folds pointing vertically upwards near the crest. This bowl may be taken as the source of Liddar river.

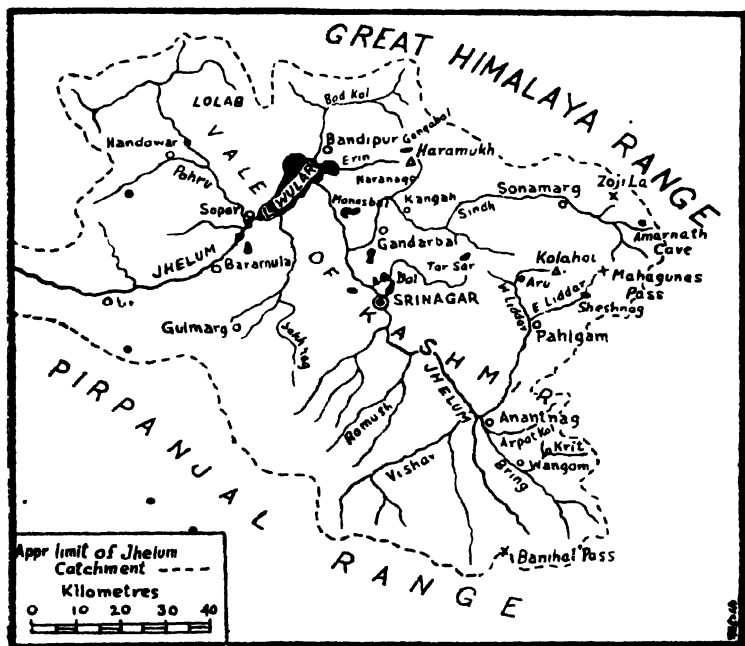
The pilgrims ascend to its west over the Mahagunas Pass, ( 4,300 metres ) below Ashtannarg, and cross over to the Sind vally.

*Sind Valley :* After crossing Mahagunas Pass, there is a bird's eye view of another great amphitheatre, backed by jagged crags of folded and ice-polished rocks. This tract is so remote that even Gujars do not come so far with their flocks. It is, therefore, a mountainscape of unbelievable grandeur and beauty, but bereft of trees or human beings. Only during August a stream of pilgrims pass through this rocky bowl along a specially prepared track.

High above Pahlgam to its east is yet another grassy meadow named Shikargah ( hunting ground ). In and around the high hills, deep forests and snow, a great variety of wild animals, providing varieties of furs are available. They are hunted for their fur. They include foxes, rabbits, deer and leopards. The fur provides a flourishing cottage industry to the people of Pahlgam, who cure the skins and sew them in attractive garments, bags, gloves etc.

*Aru Basin :* Above Pahlgam the valley of Aru ( W. Liddar ) is a broad U-shape with hanging valleys on both sides. The surrounding ranges form a rough circle of ten kilometres radius, formed of Upper Triassic light and dark grey dolomites and limestones, exhibiting a great deal of complex folding in the bare faces of rocky precipices.<sup>4</sup>

Aru and Lidder Wat stand at junctions of streams, where again triangular flats have been formed by the junction of two glaciated valleys. On the rims are peaks four to five thousand metres high. Kolahoi peak is a spire of black dolomite rising to 5,425 metres<sup>5</sup>. Glaciers descend from it on all sides, the biggest being of the same name.



Many tarns are located near the peripheries of the valley, from which many streams take their rise. Tar Sar nearly six kilometres long is the biggest of them. Their presence indicates past glaciation.

Limestone crags rise sharply in jagged forms in the higher valleys and vast accumulations of scree fan out at their bases. The whole area provides grazing grounds for the flocks of Gujars. Only the valley bottom below Lidder Wat is inhabited by Kashmiris, the focus being at Aru. Many villages in the valley produce Kashmir

art goods of paper pulp, walnut, furs etc. Agriculture is meagre and does not provide a whole time job. Winter are severe, when the valleys get heavy snow fall. Kashmiris utilize this time in producing art goods of wool, silk, papiermeche, silver, jewells, fur wicker and walnut wood. They keep warm by keeping a fire pot called 'Kangri' near their bare bosom under their woollen cloaks.

The valley of East Liddar shows geomorphological features similar to Aru. Beyond the meadow of Pahlgam, only after a couple of kilometres the valley assumes a U-shape, and a series of waterfalls and cascades tumble down into it from snowy crests. The valley provides the pilgrim route to the sacred Amarnath caves. Agriculture and fruit gardening is found in the valley bottom only up to ten kilometres from Pahlgam, and forests also disappear after another 15 kilometres.

Pissu Ghat, a zigzag track hewn into the face of a truncated spur, rises above the tree line. Dolomite crags and broad boulder strewn scree slopes border the gorge of Liddar, on both sides. The camping ground of Zajpal is situated here, the broad open slopes appearing on both sides of the river gorge.

Just above and below Zajpal there are two conspicuous breaks in the Thalweg of Liddar. The lower one appears just above Pissu Ghat where the transverse section of the valley changes from an open to a closed type. The other appears above Zajpal. These breaks emphasize the glaciated nature of the Liddar valley, being longitudinal rock steps. Some elongated rock-basin type lakes are also found in the upper course of a hanging valley joining from the south. The valley drops very steeply from corrie glaciers on the sides of a 6,500 metres high water-shed, to below 4,000 metres in Liddar.

Further up is the basis of Sheshnag lake which is fed, by snow-melt water from corrie glaciers and ice-fields

to the east and south. The upper Liddar also drops into the lake and flows out over a moraine plug. Along the northern rim of the lake there is a broad terrace called Wavjan, which is used as a camping ground like Zajpal. The terrace is made up of glacial till. It is thus, a terminal moraine of an ancient glacial snout. Similar features are found at many other places in the Himalaya, as for example at Basudhara across Alakananda, 2 kilometres away from the Satopanth-Bhagirath snout, and across Rishi Ganga valley above Badrinath.

Above Sheshnag, which is often frozen partly in summer, the Liddar is often buried under snow. Further up to the east is a huge amphitheatre, backed by polished walls of bare crags, showing a remarkable array of folded rocks, ending in folds pointing vertically upwards near the crest. This bowl may be taken as the source of Liddar river.

The pilgrims ascend to its west over the Mahagunas Pass (4,300 metres) below Ashtanmarg, and cross over to the Sind valley.

*Sind Valley* : After crossing Mahagunas Pass, there is a bird's eye view of another great amphitheatre, backed by jagged crags of folded and ice-polished rocks. This tract is so remote that even Gujars do not come so far with their flocks. It is, therefore, a mountainscape of unbelievable grandeur and beauty, but bereft of trees or human beings. Only during August a stream of pilgrims pass through this rocky bowl along a specially prepared track.

This amphitheatre and another larger and more full of corrie glaciers to the east supply the headwaters of Sind. Streams issuing from them join in a large flat plain filled by fluvio-glacial deposits, through which the Sind flows down, and on the far side plunges into a gorge to Baltal on the Sonamarg-Zoj La route.

This plain is Panchtarni, the last camping ground on the route to Amarnath. On the northern rim of the

plain is a broad sloping terrace behind which are huge talus slopes at the base of bare rocky crags. Springs similar to those found at Wavjan come out from the boulder strewn beds. The terraces are formed of morainic materials. The flat plain appears to be the bed of large glacial lake, which has been drained off recently.

The Sind descends into a steep gorge north-west of Panchtarni, and flows between great snowy ramparts, the northern one being the central Himalaya itself. It exhibit the usual forms of glaciation. A hanging valley descends into it in a waterfall just beyond Panchtarni.

Amar Ganga, a snow choked stream, flowing in a perfect U-shaped valley here descends into Sind, dropping down from the Himalaya Range. Scree fans' on both sides of it coalesce to give it the shape of a very open U, more or less a hyperbolic curve. The stream often flows underneath snown beds. This hyperbolic cross-section is yet another common land form in the highest glaciated valleys of Kashmir. It is primarily due to the gigantic size of scree and talus slopes formed by intense frost action. They spread below the rock cliffs on both sides of the valley, and make the U-shape look like a hyperbola. The accumulation of scree is due to a much higher rate of production of eroded material, as compared to agents of transport, which are too weak in Kashmir.

The group of Amarnath peaks in the central Himalaya soar above the valley to nearly 5,600 metres. The ranges here are formed of Upper Triassic limestones and dolomites at some places altered to gypsum.<sup>4</sup> From Amarnath cave one can observe a variety of folds on the polished surfaces of the precipices opposite to it. The cave itself is a cubical hollow of huge dimensions, a proof of cuboidal jointing of the rocks. Inside it there are no stalactites or stalagmites, but water oozing out from the roof of the cave, has frozen into a huge block of permanent, clear, glassy ice. At some places



water drops congeal into vertical forms, worshipped as snow "Lingas".

The Upper Trias occupy a large area in this region. They extend from north of Pahlgam, through the headwaters of Sind to beyond Gurais in the Kishan Ganga valley.<sup>7</sup> Here the "river has excavated through this limestone a broad U-shaped valley bounded on both sides by an imposing line of precipices, towering one to two thousand metres above the flat scree strewn bottom.<sup>8</sup> The Triassic limestones, stretching from near Pahlgam to Kolahoi, Amarnath and Gurais, "have furnished an abundant building material to the architects of ancient Kashmir in the building of their great temples and edifices, including the famous Sun Temple of Martand".<sup>9</sup>

Six kilometres above Baltal is Zoji La ( pass ), just below 3,000 metres across the central Himalaya range. It has been a great routeway for many centuries. From here tracks go up and down the Indus furrow, and northwards along Shyok and Nubra, over Karakoram Pass to Sinkiang.

Sonamarg, besides being a large meadow set amidst lofty mountains, is an important route centre. The village of Thajewas just below it, is a "Sarai" for mule caravans, providing pens and fodder for their stay.

At this point two large longitudinal snow-choked valleys similar to Amar Ganga valley, open out into Sind valley. Chains of corrie glaciers cling to the sides of the Thajewas valley, discharging thundering waterfalls into it. The cross-section is an open U, conditioned by scree fans on both sides forming a hyperbolic section similar to Amar Ganga.

The massive, old, morainic terrace like deposits on both sides of the main valley were formed during the Pleistocene glacial period. Chains of springs, some of them with large cave like openings, are seen in them. The bigger caves even provide shelter for flocks of sheep.

These features are similar to those found near the source of Mandakini below Kedarnath.<sup>10</sup>

There is a major break in the Thalweg of Sind below Thajewas, significantly at the junction of the two tributary valleys, which contained tributary glaciers in the past, joining the main Sind glaciers. The major rock step was produced by the greater weight of ice below this point. From Thajewas downwards this Sind flows in a deep gorge, which opens out at Sumbal into flat terraces. The valley broadens out to a funnel shape near Kangan, which was a broad estuary of the Karewa lake in the past. A hydroelectric station has been constructed on the side of a spur above Gandarbal below Kangan, by conducting the waters of Sind by a high level canal and dropping it through penstocks below the slopes of the spur.

North of Kangan the scene is dominated by the horned peak of Haramukh, 5,143 metres high. To its east is the great spur of Ogpu Dhar which joins with the Central Himalaya range near Zoji La. South of Ogpu Dhar are two strike vales, which join near Shari forest, and flow past Naranag into Sind below Kangan. Numerous corrie glaciers and tarns are found near the crest. The valleys below are U-shaped, and show evidences of past glaciation and present active frost action. The biggest glacial lake is Gangabal, below Haramukh.<sup>11</sup>

*Valleys of Bring and Arpat Kol :* These two valleys as well as Liddar converge upon Anantnag, and arms of the Karewa Lake had penetrated all of them. Arpat Kol is a very small valley, nearly three-fourths of which is a funnel shaped plain extending from Anantnag. Beyond it, we again find a triangular flat at a river junction. Here is Tsoilipur, a meeting point of mountain trails through dense forests. The watershed above is dotted with tarns. The crest is also level at the top, providing space for two meadows, Zajimarg and Putwalmarg. Gujars live in the forest nearby.

Bring river valley is larger, but has similar features.

At the end of the funnel shaped plain at the Rest House above Wangom, the valley breaks into a number of tributaries. There is a big triangular flat at Krit, where two tributaries meet. The valleys are broad and well populated. Glaciers descended through them to the Karewa lake during the pleistocene glaciation.

*Valleys North of lake Wular :* These valleys are all very small. The largest of them is Bod Kol or Madmati. Its sources are high up on the northern and western flank of Haramukh, among amphitheatres and tarns. Sarbal and Baribal Sar are two good examples of amphitheatres with many tarns inside them. The valleys are all U-shaped and glaciated. River Erin rises from corrie glaciers on the Western flank of Haramukh, and opens out above Kudr to a funnel shaped flat valley. The valley provides the shortest route from Bandipur town, situated north of Wular and connected to Srinagar and Barāmula by a motor road, to the Gangabal lake. Pilgrims on a smaller scale visit this enchanting lake, while more and more tourists and hikers follow this trail, which is noted for its great beauty, its hanging valleys, its tarns and its small glaciers, with the glistening Haramukh providing a grand back drop.

*Pohru and Lolab :* Pohru forms another major northern valley of Kashmir. The river joins Jhelum between Sopar. But a major portion of its valley forms part of the Vale of Kashmir. The focus of Pohru valley is Handowar, famous for its pears and apples. At Batargam the river breaks up into a number of tributary valleys, branching out in all directions. The valley to the east, named Lolab is noted for its scenery. It was also submerged by an arm of the Karewa lake. The upper portions of tributaries descend steeply from the watershed between the Jhelum valley and Kishen Ganga, which is comparatively lower than the other ranges surrounding the valley. It is, however, covered by deep snow every winter, and hence consists of jagged peaks and knife-edged ridges. But there are few tarns and

corris glaciers. Forest, much more easily accessible, form the chief wealth of the valley. Much timber is supplied from Pohru and Lolab to Srinagar.

## Trans-Himalayan Kashmir

The portion of India lying north of the Great Himalayan Range "Himadri" may be called the Trans-Himalayan Region of India. In Western Himalaya this region mainly lies in the State of Jammu and Kashmir.

The Central axis of Great Himalaya may be supposed to start from the right angle bend of the river Sindhu (Indus) near Sazin in Pakistan near the International border north of Kohistan, and then running towards the south-east through the Nanga Parbat massif and Amarnath peak to the northern boundary of Chamba and Kangra entering the latter near Bara Lacha La. Trans-Himalayan Kashmir lies to the north of this axis. Nearly the whole of it is drained by Sindhu and its tributaries Gilgit, Shigar, Zaskar, and Shyok. Roughly it resembles a large triangle lying between 32 to 38 degrees north latitude and 72 to 81 degrees east longitude.

The mighty Karakoram Range occupies the north central portion of this region. Beyond its western end is the basin of river Gilgit extending to the northern borders of the State. North of its eastern end is Shyok valley which spreads out eastwards to salt encrusted plains, which include Lingtzitang, Aksai Chin, and Soda plains. To the south of these three sub-regions lies the Sindhu furrow. The rugged complex of valleys and ranges to the south of this furrow may be divided into two more sub-regions, Zaskar to the west and Rupshu to the east. Further, the middle portion of the region consisting roughly the valleys of North Shigar and South Shigar is called Baltistan.

Again nearly three-fourths of the eastern portion of Trans-Himalayan Kashmir forms the district of Ladakh,

though Ladakhis occupy mainly the valleys of Sindhu and Shyok around Leh.

The sub-regions mentioned above may be further subdivided into micro-regions. A detailed regional discussion is given below ;—

*Gilgit Basin :* River Gilgit is a tributary of Sindhu, ( The Indus ) and joins it six kilometres above Bunji at a height of 1,450 metres above sea level. Along the rim of the basin are high mountain ranges covered by eternal snow and dominated by Rakaposhi towering 7,788 metres above sea level, 25 kilometres north of Gilgit town. Its biggest tributary is Hunza, which descends from the northern border of the State through deep and inaccessible gorges cut into steep mountains. Another tributary is Ishkuman, which rises near Afghanistan border in Hindu-kush range, and flows south through a deep gorge. Gilgit itself rises further east near Ghizar close to the border of the State.

The altitude along the rivers in this part of the Basin is below 2,000 metres, and so very favourable for human settlement. River terraces are intensively cultivated and the adjoining hill slopes are covered by orchards. The climate is mild and temperate. The density of population is more than 1,000 per square kilometre in the arable area, though it is only 10 to 20 per sq. km. in remote areas. The terraces are irrigated by cleverly made systems of canals taking water from various levels along snow-fed rivers descending from the mountains. Orchards on the hill slopes are also irrigated in the same manner.

Wheat grows during spring and early summer, the seeds being sown before the onset of winter, which sprout in early spring as the snow melts. Later on the same fields produce summer crops. In well watered fields rice is grown and in drier places maize and millets are raised. Barley is grown at a higher elevation. The fields are heavily fertilized by cattle dung, which is placed at a point where the irrigation water enters the field, so that it

is automatically mixed up with water and spreads evenly in the field.

A great variety of fruits are grown according to suitability of land. Grapes, pomegranates, peaches, plums, apricots, pears, and apples are grown. Nuts grown include almonds, walnuts, chestnuts, and "Chilgoza." Rain from western disturbances is very helpful to fruit orchards and wheat.

The low level and the consequent warmer climate has helped in the growth of temperate hardwoods, such as oaks, walnuts, chestnuts, beach birch, and the majestic "Chinar." Timber is extracted and forms an important export of Gilgit.

The terraces also provide sites for developing towns and villages. Roads and tracks are easily built along them. Gilgit town is the focus of communications in the basin. Roads run up and down the main valley and also up the Hunza. The road down the valley further goes down and up the Sindhu. Downwards it goes to Bunji and Chilas, and then enters Pakistan. The upper branch crosses river Gilgit by a bridge and moves up the Sindhu through the formidable Rondu gorge to Skardu in Baltistan.

The valley in the neighbourhood of Gilgit town is a paradise set amidst a rugged grandeur of inhospitable snowy ranges and giant peaks. In fact it is the richest valley in the whole of Trans-Himalayan Kashmir. It has an easy approach from Pakistan by the Kunhar valley road and another road along the Sindhu, connecting it with Rawalpindi. The road to the Vale of Kashmir is a difficult one. It goes *via* Bunji and climbs up the Astor valley over the Burzil Pass to Gurais, from where it has again to climb the Razdan Pass to reach Bandipur and Srinagar.

To the north of Gilgit are a number of remote valleys, the most interesting among them being the Hunza valley. It is approached from Gilgit by a tortuous and dangerous jeepable road clinging to cliffs in the Hunza gorge.

Two small towns Baltit (Hunza) and Nagar are situated in a small oval shaped bowl surrounded by towering mountains rising at some places above 7,000 metres. The seclusion of the valley is for all practical purposes complete. The people here have little contact with the outside world. They are hard-working and industrious. The bowl is intensively cultivated. The hillsides are terraced for both cultivation and agriculture. On the whole, they are a happy and contented people. The mountain environment has made them tough and hardy, so much so that they are used as high level porters by mountain climbing expeditions to the Karakoram peaks and Nanga Parbat. They are a counterpart of the Sherpa of Solakhumbu in this part of the world. The track from Hunza leads further north to Pasu, where it bifurcates to the east and the north. The eastern route leads to the Trans-Karakoram valley of Shaksgan. The northern route leads to the Kilik, Mintaka, and Khanjerab passes on the border to the Taghdumbas Pamir.

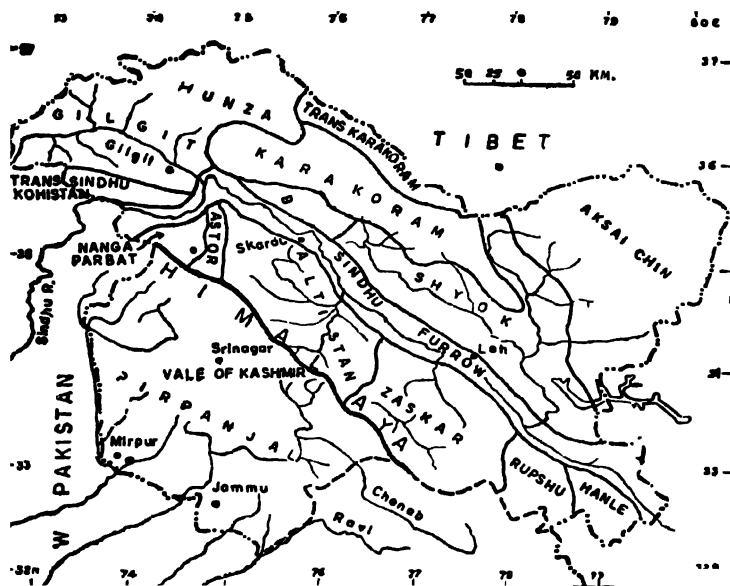
Two Mirs administer the valley. The Mir of Hunza with his capital at Baltit governs the north side of the river, which is sunny and so, more green and fertile. Wheat, barley, and fruits including apples and grapes are grown here. The south side of the valley is governed by the Mir of Nagar. It is cold, as the long shadow of Rahaposhi falls upon it, being larger in winter.

Two more remote valleys in the north are Ishkuman and Yasin. Being high they grow more barley, some of which is exported. There is also more herding and grazing, which is more or less prevalent in the whole of the Gilgit basin. The herders practise transhumance. They mainly keep sheep and goats. They are experts in making cheese.<sup>4</sup>

*Trans-Sindhu Kohistan* : This is a small strip of extremely rugged mountain slope lying between the southern rim of Gilgit basin along the crest of an extension of Ladakh range westwards across the Sindhu, and the Sindhu



itself in the south. It is a portion of a larger region called Sindhu Kohistan, part of which lies in Pakistan. The area is remote, undeveloped, and inhabited by some tribal people. It is extremely rugged and forested.



Map 10

**Karakoram :** This mighty mountain range extends from Hunza in the west to Shyok valley in the east. It is second only in height to the Himalaya, for it boasts of nearly fifty peaks rising above 7,000 metres, which include Mt. Godwin Austin or K<sub>2</sub>, 8,611 metres high, the second highest peak of the world. Further, the Gasherbaum group of four peaks are all about 8,000 metres. Peaks nearing 8,000 metres, include Rakaposhi (mentioned earlier), Disteghil Sar, Kanjut Sar, Haramosh, Masherbrum, Saltoro, Saser, and many others. But the whole range and its ramifications spread over a high plateau like base, nowhere below 3,000 metres. The ridge tops rise more or less 2,000 metres above the valley bottoms, while in the Himalaya this difference is about 4,000

metres at a number of places. The most famous examples of such tremendous contrast are the Sindhu gorge at Bunji, the Arun gorge below Mt. Everest and the Krishna Gandaki gorge below Dhaulagiri. In the former the differences of level between the valley bottom and the Nanga Parbat is nearly 7,000 metres. The Karakoram Range, therefore looks much more subdued than the Himalaya. But perhaps its average altitude is greater, and its latitude is higher, and so this keeps it permanently in the grip of snow and ice. The valleys are generally not of rivers but of huge glaciers and the leading agents of erosion are frost and ice. The ridges have a highly serrated look and the landscape abounds in sharp aretes and horned peaks. The slopes are concave. K<sub>2</sub>, the highest peak, is the world's biggest horned peak. Like Mt. Everest it is also formed of limestones. Landforms resulting from active glacial erosion are the chief components of the scene.

The glaciers of Karakoram are some of the largest mountain glaciers of the world. They are always overlaid and completely covered by the rock debris and moraines. This is due to the fierce rock shattering and disintegration by frost, producing huge masses of weathered material, which can be transported by glaciers only very slowly. The snouts of the glaciers are choked by tremendous heaps of terminal moraines. Water erosion is nearly absent, and wind can carry only finer material. The movement of the glaciers is generally very slow, hardly 50 centimetres per day. This is, however, controlled by topography, and the extent of supply from the fern basins. Steeper slopes induce faster movement. In a few cases, specially of tributary glaciers, ice-falls are created and there is schollen movement among blocks of ice. Earth tremors may help in rapid descent of glacier tongues.

Further down near the snouts, water pours out from ice caverns, running deep under the ice as englacial streams. Small ephemeral lakes are formed on the surface

of the glacier, which may suddenly disappear into the ice down below. Small lakes and streams are also formed at the edges behind the lateral moraines below rocky cliffs.

Further down, in the lower ablation zone, slow ice movement and little precipitation are responsible for vast accumulations of debris. This is more so, as the removal of rock waste accruing from the very active weathering processes is very slow. This is specially so on the slopes of Karakoram, where glaciers flatten out, and discharge streams laden with outwash, over huge accumulations of moraines and talus cones.

At the western end of this range, the mighty Hispar glacier nearly 60 kilometres long, slopes down towards the Hunza valley. Both to its north and south are snowy peaks rising nearly 7,000 metres. The range south of the glacier, beginning in Rakaposhi is named Kailash Range. Further east are two more mighty glaciers Biafo and Baltoro. They are 10 and 50 kilometres long. They pour their melted waters to the south in North Shigar valley. North and north-east of Baltoro glacier is the highest portion of the range. Here are the Gasherbaum group of peaks dominated by  $K_2$ , on the north. It is a great icy waste, and is more formidable and massive than the Everest and its satellites Lhotse, Nuptse and Pumori, but for the fact that  $K_2$  is slightly lower than Everest. South-east of Gasherbaum is the longest glacier of Karakoram named Siachen, being 70 kilometres long. Nubra, a tributary of Shyok takes its rise from its snout. North of this glacier is another big peak, Teram Kangri, over 7,500 metres high. From it descends yet another big glacier named Rimo, which discharges into the Shyok. Karakoram range extends across this river into the wastes of Chang Chenmo and loses its identity.

*Aksai Chin* : East of the main valley of Shyok the landscape changes completely. It is generally a vast undulating plain with low snowy ranges embossed upon it, which trend roughly northwest to southeast or simply west

to east. In between them are shallow depression filled with salt encrusted wastes and lakes. The whole region is strewn with rock debris, gravel, and boulders, which is the end product of disintegrated ranges of the past. It is a sort of a frost-action peneplain, resulting from rock-shattering by ice and sub-zero temperature. Much of the present landscape of this region has been moulded by the ice cap which enveloped it during the Pleistocene glaciation. The ice cap spread all over the Tibetan Plateau at this time. As it waxed and waned by temperature fluctuations, it behaved like a giant sand paper and produced landforms somewhat similar to the glaciated plains of Europe and North America. In all probability the ice cap melted *in situ* and dropped the rock debris on the ground. The result was a general levelling. Glacial debris in huge quantities lies scattered all over the place. It has disrupted drainage here and there, as for example, the 200 kilometres long, ribbon shaped Pangong Lake was formerly joined to the sharp elbow of Shyok river near Shyok. Rainfall in this region is nil, and the absence of normal erosion will make the process of removal of this debris very long indeed. This is the main difference between this glaciated surface and the European and American glaciated plains. Absence of proper drainage due to its disruption by glaciation and the present lack of rainfall has produced many salt-encrusted lakes. There are a few tributaries of Shyok, which flow westwards in shallow valleys. Among them, Chang Chenmo, Galwan, and Chipchap are worth mentioning. In the adjacent part of the Tibetan plateau the topography is very similar. This region is called Chang Tang.

There are a number of plains in this undulating area. The central portion is called Lingtzi Tang while Aksai Chin is north of it. Further north are two other smaller plains named Dapsang and Soda plains. Wild asses roam in packs over this region, and eat the scanty grass found in favourable spots. A few people visit this inhospitable

region to collect salt, soda, borax and carry it by mules. The wild asses approach these occasional human visitors, without any fear and gaze at them in great curiosity.

A boy born in this region to a salt merchant from India, was gripped with fear, when he came to India and saw rain falling for the first time in his life. Bleached bones and skulls lie at many places in the salt plains, reminding one of the grim fate of those rare visitors who died of cold, hunger or thirst. Only a very small number of herders live in the western margins of the Plains, where some grazing is available in depressions, and some barley can be grown. Their main food is roasted and pounded barley, dried meat, cheese, and an alcoholic drink made from barley.

*Trans-Karakoram* : This secluded micro-region lies north of the Karakoram Range. It has easier access to the north towards Yarkand than towards Kashmir. It consists of the high valley of Shaks-gam or Muztagh, north of it is Aghil Range, which is much lower than Karakoram. Passes such as Sakang and Aghil lead to the Zafrafshan valley in Yarkand. The chief locality is Darwaza, from where paths lead to Pasu and Hunza in the east and Taghdumbash Pamir in the north. The main occupation of the people is herding.

*Shyok Basin* : After Sindhu, Shyok is the next largest river of Trans-Himalayan Kashmir. It occupies an area between Karakoram and Aksai Chin. Its tributary valleys extend into the snowy ranges of Karakoram to the west, and also spread over the rolling plains to the east. It may be called the highest river basin in the world. It joins the Sindhu 50 kilometres below Khapaln at a height of 2,500 metres, which is its base level of erosion.

It is fed by glaciers of Karakoram. A very interesting phenomenon of periodic glacial movement is observed in the Shyok valley. This is the periodic formation of an ice dam across the river, the creation of a temporary reservoir behind it, and its discharge when the dam bursts. The

glacial ice dam is produced by the advance of a tributary glacier named Chong Kumdan from the west once in about 50 years. The lake produced by it is about 15 kilometres long and extends up to the junction of Chipchap river with Shyok and near the Rimo glacier from where Shyok takes its rise. This ephemeral lake has been named as Gapshan lake. Previous records of the advance of Chong Kumdan and the formation of the ice dam are for the years (i) 1832-33, (ii) 1876-77 and (iii) 1923-24. A smaller glacier below this point, named Kichik Kumdan also is prone to sudden advances, but as it rides over loose moraines and silt, the river water percolates under it and appears three kilometres below it. So it is unable to form any reservoir. The phenomenon has been studied in details by Kenneth Mason and Lyall Grant. According to them the tongue of Chong Kumdan glacier was in a degenerate state in 1923. It advanced rapidly in 1924-25 and formed a dam. This is due to the accumulation of snow on higher altitudes beyond a critical limit, which suddenly pushes downwards and forces the glacier to advance suddenly. Perhaps this periodic movement of glaciers, or snow slides and avalanches occurs at many other places in Karakoram and the Himalaya. The dam burst in stages in 1926, 1929, and 1932. This is due to seasonal advance in winter and retreat in summer. It has been predicted by Kenneth Mason that the next advance of Chong Kumdan and the formation of the ice dam and lake Gapshan may be in 1968-69, and the dam may burst in stages during 1971, 1974, and 1977 respectively.

Three parallel ranges cut across the Shyok basin. The biggest and the northernmost of these is Karakoram. The next is Kailash Range, which advances through the North Shigar valley and continues in the angle between Shyok and its tributary Nubra and crosses the latter north of Tegur. Then, it reaches the angle of Shyok and Shyok village and crosses the river north of it. Further, it proceeds north of Pangong Lake and cuts through it near the

International border and passes into Tibet, where it reaches Mt. Kailash in the north of the lake Manasarowar. The third mountain is Ladakh Range. This Range starts in Gilgit and crosses south of the Sindhu and Bunji and recrosses it to the north at Khartaksho.

Shyok valley provides a number of very important route, the most important of them being the road to Sinkiang. It starts from Leh and passes over the Ladakh Range by Khardung Pass. It, then, descends into the Shyok valley crosses and goes across Nubra river at Tegur. Again it ascends along the Nubra and then crosses the Karakoram by Saser Pass into the upper Shyok valley, again crosses Shyok and reaches Murgo, from where it passes northwards through the Despsang Plains to Daulat Beg O'di near the Karakoram Pass. From here the route enters Sinkiang and follows the Karakash river to Khotan, where it meets the "Silkroad" running east-west, south of Takla Makān desert. The Chinese have now built two roads across Aksai Chin which bypass the Karakoram route. From near the elbow of Shyok a route goes towards south-east to Chushul which is a very important army base with an aerodrome. The route goes further south to Thangra on the Sindhu, where it meets the route along Sindhu from Leh to Demchok and beyond towards western Tibet. From Chushul a route goes to north to Aksai Chin, a branch of which skirts Pangong Lake. Yet another route crosses Ladakh Range over Chorbat Pass, which connects Dukhar on the Sindhu below Leh with Khapalu on Shyok. From here this route goes down the Shyok to the confluence with Sindhu and further down to Skardu, the capital of Baltistan. Another route from Khapalu crosses the Shyok to Korku and proceeds to Shigar in Baltistan.

Localities are generally caravanserais, where some grazing is available for mules. There was much trade along the Leh-Khotan route before India's relations with China deteriorated. The localities thus now cater to the need of the caravans, and are staging points for them. Through-

out Aksai Chin and Shyok basin the peoples are generally Buddhists who follow Lamaism. They are very much religious minded. Lamas reside in place of worship or "Gompas" These places are also considered as the seats of learning. The people practice polyandry and a wife has many husbands. Due to extreme cold bathing by water is scarce. The body is rather cleaned by messaging with yak butter. The whole social structure is built around religion. The head Lamas are the spiritual guides, benevolent money-lenders as well as rulers. While mules provide transport, yak and sheep provide meat, wool, milk, butter and cheese.

The above facts of human geography are common, nearly all over high Himalaya and the Trans-Himalaya, with slight local variations. We find Lamaism prevailing in Tibet, Sikkim and Bhutan. It is also prevalent in the high regions of Nepal.

*Sindhu Furrow* : This broad furrow has been dug right across the Trans-Himalayan Kashmir by the mightiest of all the rivers of north-western India. The river flows from south-east to north-west, and takes a right angle bend around the Nanga Parbat massif near Bunji. It enters India near Demchok, where the furrow is more than 4,000 metres high. Near Leh it drops to 3,500 metres and at Skardu to 2,350 metres. At Bunji it is 1,450 metres. The furrow is a great route way, and Leh, the capital of Ladakh, is the focus of all the routs. Being lower in the altitude the furrows has a pleasant climate compared to the rest of the region. However, it is very cold in the west of Leh. Nearly all along the furrow the river is flanked by broad terraces on which spread out gigantic fans and talus cones, lined up below the enclosing mountains. At three places, however, the Sindhu cuts transverse gorges through the Ladakh Range at Thangra, the Khartaksho and the Bunji.

The western portion of the furrow is distinctly different from the eastern portion. It may take its form from Khartaksho above the confluence with Shyok. The



climate of this portion is cold, dry and extreme. It is illustrated by the average temperature and rainfall figures for Leh in centigrade and milimetres for twelve months.

	Jan.	Feb.	Mar.	Apr.	May	Jun.
Temp. ...	8.2	7.3	6	6.1	9.9	14.3
Rainfall ...	10.2	7.6	7.6	5.1	5.1	5.1
	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Temp. ...	20.3	16.1	12.1	5.9	0	5.5
Rainfall ...	12.7	12.7	7.6	5.1	0	5.1
Annual Average Tempm.				...	5.26°C	
Total Annual Rainfall				...	84 mm.	

January is the coldest month and July the hottest. This is generally so in other parts of the world, but for India June is generally the hottest, due to the break of the monsoon, which is too feeble in Leh to have any influence on temperature. The average temperature is below zero degree from November to March. The rainfall is insignificant being 84 milimetres or about three and a half inches. This is also in the form of snow. July and August are the months of maximum rain and the lower maximum rains are found in December and January. The sun in the day time is quite warm, the temperature rising to 10 degree C. even in winter, or 20 degrees in summer. But the nights are extremely cold, as quick radiation of heat cools down the land very fast. There are very strong winds, specially those in the winter from the north.

Many villages and towns are situated in the furrow. Their main function is to provide shelter and food to the travellers and caravans. There are pens for keeping horses and mules, and hay is stacked to feed them. Serais give food and shelter to people. Barley, wheat and buckwheat is grown at suitable places. Some fruits and nuts are also grown. A few poplars add some relief to the bleak area. Houses are built of stone and have two or more storeys. Forts and Gompas are often multi-storeyed. Leh is the

centre of Ladakhi culture. It has been called a "Lhasa in miniature." The people here are well dressed and cultured. Nearly every household provides one male member to be nurtured in some monastery as a Lama. There are some famous monasteries such as Lamayuru in the west of Leh. An essential feature of the cultural landscape are stone structures called Manis and thousands of fluttering white and coloured flags on which "mantras" are printed.

The western part of the furrow above and below Skardu enriched with Muslim culture. Being lower in altitude it is warmer and so agriculture is more intensive. The furrow is fairly broad near Skardu, the capital of Baltistan. Further down, the Sindhu cuts a deep gorge in the mountains near Rondu and turns at a right angle towards Bunji, around Nanga Parbat, and then enters Pakistan.

*Baltistan* : This Sub-region includes the basins of North Shigar and South Shigar rivers, north and south of Skardu. The Sindhu furrow divides it into two parts. The two rivers are fed by glaciers of Karakoram in the north, and the Himalaya in the south. North Shigar joins the Sindhu. This valley is extremely rugged and cold, as its altitude is very high. Only up to Shigar town where the river turns at right-angles to the north-west round a spur of Kailash Range, there is some cultivation of barley and wheat.

Cultivation is more intense in the Sindhu furrow near Skardu. There are many orchards. Pines and fir trees grow on lower hill slopes and poplars and willows grow in the valley. The soil is generally gravelly and infertile, composed of outwash material. But there are patches of better soil also. Skardu is situated at a height of 2,347 metres south of the Sindhu opposite to its junction with Shigar. It is the capital of Baltistan and, is an important route centre. It is joined by a regular air service to Gilgit and Rawalpindi.

In the higher portions of Shigar valley fans and talus cones descend from the mountains and provide pasture. Grazing is more important in higher parts of the valley.

Here the river bifurcates. The northern branch continues in the same direction till it reaches the snowy southern slopes of Karakoram, and the main branch turns east and reaches the snout of Baltoro glacier. This portion of the valley is called Braldah. It is sparsely populated.

South of the Sindhu furrow is the Ladakh Range running from Bunji to Khartaksho. Hanging valleys drop down from it steeply into the Sindhu. The lower slopes are covered by coniferous forests while meadows appear higher up, where nomadic herders roam with their flocks of sheep.

South Shigar river rises in a small basin bound by Ladakh Range in the north, the Himalaya in the south and a spur from Ladakh Range to Minimarg, running north-south to the west. Here is a large desolate plain at an average height of 4,000 metres called Deosai Plain. Some of the bogs and marshes in it are impassable. The plain is so desolate and bleak that even herders do not like to come here. And they believe that it is haunted by spirits. Swarms of large black gnats, a few burrowing animals and bears inhabit it. A route from Skardu runs south over the Ladakh Range and then across the Deosai plain to Minimarg. From here it goes to Gurais valley, climbs the Razdan Pass and enters the Vale of Kakhmir.

Further down, the Shigar meets a number of tributaries, the more important being Shigo, Dras, Suru, and Wakka. They all join at Kargil, and the combined river flows down north into Sindhu opposite Marol. This portion of the valley is named Dras. Both Dras and Kargil are very important staging places on the road. The road has a vital military importance for India being the leading supply line of our army in Ladakh.

Agriculture is poor in the upper portion of the valley, but below Kargil it improves. Barley, maize, melons, grapes, and apricots are grown here.

Baltis are generally poor people and have to struggle hard for existence. They are Muslim. While Ladakhis are polyandrous and Gilgitis are polygamous, the Baltis

are generally monogamous. The whole of Baltistan is thinly populated, except the Sindhu furrow.

*Astor Valley* : This lovely valley lies between the north-south spur separating it from the South Shigar valley to the east and Nanga Parbat to the west. The source streams of the valley are located in the northern slopes of the Himalaya, including the mighty glaciers of Nanga Parbat. It slopes northwards and opens out in the Sindhu gorge below Bunji. The average height of the valley is 2,700 metres. This altitude encourage dense forests on the ridges and spurs. While poplars, willows, chinars and walnuts occupy the valley bottom, pine, cedar and fir trees occupy the hill slopes. Alpine meadows stretch below the snow line. Villages are found in the valley, where intensive agriculture is practised in the terraced fields. The usual crops wheat, barley, maize and some paddy are grown. There are many fruit orchards. The people are akin to Gilgitis and are Muslim by religion.

Astor Valley provides an important route from the vale of Kashmir to Gilgit. Along this route other localities are Sardar Chowki, Chillam and Godai. Astor and Godai are located in attractive surroundings, hemmed in by snowy peaks, forests and meadows. The climate is temperate as the altitude is not very high. But the valley is rather remote and hence has not become a tourist's paradise. Also for this purpose the motor road will have to be extended the Buzil pass.

*Nanga Parbat* : Though Nanga Parbat is a Himalayan peak, its huge northern and eastern slopes lie in Trans-Himalaya. It is the highest peak of the Kashmir Himalaya. It sores to 8,126 metres and is situated at the westernmost end of "Himadri" or the central axis of the Himalaya. The great Himalayan fold waves are wrapped round this massif and turn sharply at right angles from north-west to south-west. Due to this syntaxial bend the outer sedimentary rocks, are highly metamorphosed. They cover the intruded granites forming the

core of the massif. The peak region is made up of limestones. Huge glaciers descend steeply from the mountain slopes in all directions. They are broken by ice-falls and shattered by crevasses. The biggest glacier is Rakiot, which descends northward to the Sindhu valley. According to Finsterwalder and W. Pillewizer, who recorded the movements of the glacier by photogrammetry, Rakiot glacier is moving down fast at the rate of 800 metres per year. It is tumbling down in big blocks of ice clods or *schollen*, which move downwards, while there is a separate relative movement of ice in each block.

These mountains fell to the share of Germans for the purpose of conquering it. The expeditioners usually tried the Rakiot route. Yet the climbing was so difficult that many expeditions failed. The mountain got the distinction of being the biggest killer. Hermain Buhl finally climbed it with great difficulty. He was, however, killed in a latter expedition in Karakoram.

*Zaskar* : This sub-region lies between the Sindhu furrow and the crest of the Himadri Range east of southern Baltistan. It is drained by the river Zaskar and its tributaries. The average altitude of the regions is between 3,000 to 4,000 metres. There is a regular SE-NW trend of the interfluves and the valley bottoms. This has resulted in a rectilinear pattern of drainage. The rivers flow either in consequent longitudinal valleys or cut the interfluves in transverse gorges. Right through the middle of this region runs the Zaskar Range, which has the same trend. It continues through Rapshu and Hanle into Tibet.

The whole region is a glacial waste and is more desolate than other surrounding areas. Large glaciers at the valley heads and smaller hanging and corire glaciers come down from the ranges. Glacial till, gravel beds and screes choke the valley bottoms. The soil is infertile. Unimportant trails go along the valley bottoms, or occasionally cross the passes over snowy ridges. The population is extremely thin and is found scattered in tiny villages strung

along the valley bottoms. Herding is more important than agriculture. Larger villages are located at river junctions, where triangular pieces of flat lands are formed by the huge amount of debris brought by the rivers. The largest town of this region, Padam, is situated in the valley of Zaskar, where a tributary joins it and forms a large triangular flat area. Char and Phe are two other big villages in the same valley.

*Rupshu* : This sub-region lies to the east of Zaskar. Here, again, the land forms simulate the Aksai Chin and Lingtzitang plains. It lies between Sindhu and Himadri like Zaskar. There is even a plain called More Plain in the north-western portion of Rupshu, and in internal drainage basin, in whose centre spreads a large lake named Morari Tso. It is 20 kilometres long and 5 kilometres wide. It is encrusted by salt and borax on all sides. Of course, it is a salt water lake. The cultural landscape is also similar. The people are Buddhists and follow Lamaism.

This region is also very thinly populated and is in a remote position. Besides the Manali, Keylang, Sarchu, Leh road there are a few lonely trails. One of these connects Morari Tso with Spiti valley by crossing the Himalaya over Parang Pass. It passes through Kiandom near the southern shore of Morari Tso and passes northwards touching a number of smaller lakes and finally joining the road to Leh in the More Plain. Much of the area around Morari Tso is 5,000 metres high and is uninhabited. Another trail from Kiandom goes east to Chuntar.

*Hanle* : This is perhaps the most remote sub-region of Trans-Himalayan Kashmir. It lies in the south-eastern corner of this. Movement inside and outside is extremely difficult. Its south-western boundary is formed by Zaskar Range. The Ladakh Range passes through its middle. North-east of it, is the river Sindhu. Further east, the Kailash Range which also touches Hanle.

A small tributary of the Sindhu drains, the central part of Hanle moves northwards. On it is situated the little town of Hanle, surrounded by ranges rising over 5,000 metres. But the relative height is not much, as Hanle town itself is situated above 4,000 metres. A route connects it to Kiandom, and a more important route runs down the valley to the route along the Sindhu going down to Leh and up to Gartok in western Tibet. This last route passes through the eastern part of Hanle. East of Sindhu, the land slowly rises above 5,000 metres. Further up, the Sindhu is the border town of Demchok.

Generally speaking the whole of the Trans-Himalayan Kashmir is a cold, bleak, remote and a thinly populated region. Its major function is the maintenance of roads, caravan routes, and trails. The people in its eastern half are Muslims. They are polygamous. The best portion of this region is located around Gilgit. The people are fond of growing fruits.

The eastern half is more bleak and cold. The people here are Buddhists and follow Lamaism. They are polyandrous. The essential features of cultural landscape are Gompas or monasteries. The region is extremely remote. Much of the region is uninhabited. On the eastern margin, are found bleak salt encrusted plains, with salt water lakes here and there. The whole area is laden with boulders, gravel, and glacial debris. The rainfall is practically nil, and so the drainage is disrupted. Only wild asses inhabit in this cold, bleak, wind-swept, open and empty landscape. The remotest of these remote regions is Aksai Chin.

## Upper Beas Valley

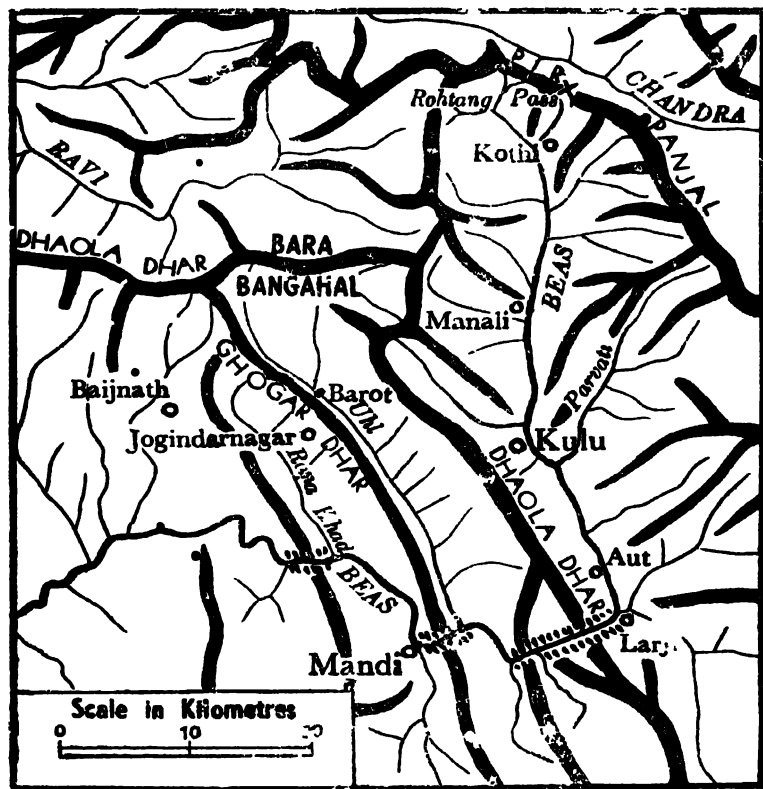
River Beas or the Bipasha is one of the five rivers of Punjab, the land of five rivers which has been partitioned by the creation of Pakistan. It is one of the three rivers whose waters have fallen to the share of India. In fact, it is the main tributary of the river Sutlej ( Shatadru ) and joins it at Harike.<sup>1</sup>

The whole of the basin of the Beas lies south of the Pir Panjal Range which extends from Kashmir to Kulu and forms a watershed between the Beas and the Chandra which runs nearly parallel to north of it and flows into the Bhaga forming the Chenab or Chandrabhaga.

The Beas rises from the western slopes of Beas Rikhi, a peak 4,622 metres high, one km. west of the Rohtang Pass ( 3,978 metres ) astride Pir Panjal. The peak has a perfectly conical shape and the pass goes through between this and another similar peak to the south-east. Severe frost action has shattered rocks to the rectangular boulders which lie strewn along the pass. The northern wind which blows through the pass in autumn and winter is extremely severe. It roars down the valley and is felt even at Manali, 100 metres below. The crest of Pir Panjal and various spurs treading southwards from it present a perfect example of erosion by frost action going on actively at present, producing aretes, horned peaks and a jagged sky line of bare frost-shattered rocks, which can be seen best in September when snow cover is minimum. The biggest spur is Beas Kunde-ri-Dhar and one can have a grand stand view of it from the Rest House at Kothi. A number of tarns, cirques and corrie glaciers are found just below the crest. Large talus cones have formed on the edges of valley beds below



and have been often covered by alpine vegetation and grass. Patches of grass-covered gentle slopes below the crest are frequented by flocks of sheep which semi-nomadic Gaddi men and women tend during summer.<sup>2</sup> They are called Thaches in this region. A "Thach" is equivalent to an Alpine meadow in Switzerland or a "Bugiyal"



Map 11

in Garhwal<sup>3</sup> or a "Marg" in Kashmir. Are-ra-Thach is seen just above Kothi. A huge natural cave serves as a shelter for the sheep. The social customs of Gaddis are somewhat different from those of other Himalayan nomads such as Joharis and Anwals or Kumaon.<sup>4</sup> Their transhumance consists mainly of moving

on to the Thaches over the Dhaula Dhar and Pir Panjal in summer and coming down to the permanent dwellings in the valley in winter. The flocks of sheep they graze are their own property unlike those of Anwals.

The Beas proper has a much smaller basin than the first two tributaries which join from east and west below Kothi. They get snow-melt water from a larger number of corrie glaciers and ice fields, A small tarn is situated just east of Beas Rikhi in Shahra Phat Thach. The valley form up to Kothi is a broad open U with waterfalls debouching into the main valley from hanging valleys on both sides.

Just below Kothi the river plunges into deep I-shaped gorge hardly ten metres wide and descending 300 metres within a distance of hardly a kilometre ; and after tumbling down over a series of waterfalls flows out then into a very broad valley near Ruara. Here it is joined from the east by the Seri Nal and from the west by the Khanor Nal. This major break in the longitudinal profile of the Beas may be explained easily by the common theories of glacial erosion, the greater weight of ice at the meeting of two tributary glaciers digging a deeper valley. or the protectionist theory explaining the deeper valley base by earlier melting and erosion. Similar "steps" in the longitudinal profiles of Himalayan rivers are found in some other places, such as at Son Prayag on the Mandakini.<sup>5</sup> The river is at present cutting into this rock step, trying to regrade itself to normal form. Patches of agricultural land appear for the first time near Kothi and Ruara, with a few huts scattered here and there. Barley, maize, wheat, potatoes and some rice are produced in difficult climatic conditions and on poor fluvio-glacial soils. From here downwards bold cliff like faces of truncated spurs stand on valley sides. From near Rohtag pass they can be very easily recognised. In between the spurs a series of waterfalls, tumbling down into the valley, reveal the presence of hanging valleys. On the lower

portions of these streams watermills are set up at every conceivable place to grind flour and do a score of other jobs. Below Bashisht, a small village beside a hot spring, there are eight watermills on a small stream. A hot bath in the spring water is very refreshing and is supposed to have curative values.

A large flat fluvio-glacial fan of unusually big size with a base of about 3 kilometres and thickness of nearly 10 metres of deposits is seen standing up along the eastern bank of the Beas. Its size is too big for its present producer the Seri Nal. Some mighty glaciers of the past seems to have brought this huge material, Large deposits of eroded material are a feature of the higher Himalaya. They have been explained by a great severity of frost action and comparatively slow removal of it.<sup>6</sup> Its soil is sterile and the surface is a boulder-strewn wilderness. The old village of Manali is perched on a large talus cone, where in all probability the glacial material is covered by recent fertile alluvium on which maize fields flourish. A gaping I-shaped gorge produced by the Halindi Nal is also observed above the valley to its east. This is the result of the hanging valley of a large stream now regrading itself and cutting into the steep rocky valley side.

Below Manali and around this village the soil improves and there are many river terraces. The altitude nearly 2,000 metres. Though dense forests of tall hefty deodars clothe the hill slopes, many deciduous trees appear in the flat portion of the valley bottom. Chestnuts, walnuts and oaks are common. Brown forest soils, produced in association with these trees, have been found to be very good for temperate fruit orchards. Credit goes to one Major Banon who settled here to grow orchards and produce a great variety of improved fruits, specially apples which have found a ready market in the plains of India. Plums, pears, peaches, apricots, parsimmons and cherries are also grown. Potatoes are a very important crop in the surrounding hills, for they grow easily in podzol soils associated

with pines. Both rice and maize are grown in suitable situations as food grain crops.

Hemmed in on all sides by knife edged snow covered ridges the scenic beauty of the valley attracts many tourists.

The valley broadens out considerably below Manali and up to Aut when the river enters the narrow transverse Larji gorge cut through Dhaola Dhar range, there are many remarkable broad terraces on both sides of the river. This is the famous valley of Kulu. Large terraces in this region have always attracted zamindars and petty kings to build their capitals. The Maharaja of Kulu had his seat at Kulu, alternatively called Sultanpur, near one such terrace. Today on this terrace is held a very large fair during autumn. The seat of Raja of Bilaspur, another hill kingdom, was also on a large terrace beside the Sutlej. This has now been submerged by Govind Sagar. The capital of the past kingdom of Chamba is also located on a river terrace on the Ravi.

The apple orchards are mainly owned by Major Banon and his descendants. Feeble attempts are now being made by the Government to propagate them among villages. Gaddi nomads who roam with flocks of sheep in the surrounding hills, come down to the terraces and their villages in autumn.

Wool is a very important commodity of Kulu and Lahul. Much raw wool comes over the Rohtang pass. It is spun and woven into a great variety of blankets (Gudma), shawls and scarves. Huge quantities of woollen products are sold during the Mela, including the jaunty Kulu cap, much preferred by visiting tourists. The pashmina shawl is famous for its excellent quality. It is produced from very fine woollen hair picked up by hand by expert pickers. Rice is grown on the flat surface of terraces, while maize is grown on undulating ground further up.

The wide valley and the terraces have done much to intensify human activity in this secluded valley. Yet seclusion and inaccessibility have their stamp on social

customs in this part of the valley. Many adjacent tributary valleys have worlds of their own. Each village has its own "Deota" or God, who possesses landed property. The head priest wields much power. Disputes are generally settled by villagers among themselves or by the head priest. Recourse is seldom taken to go to courts situated far away in district head-quarters to settle disputes. During the Kulu Mela (fair) in autumn, the village Deotas are brought by procession from the neighbouring villages to the terrace at Kulu to greet the chief Deota of Kulu.

The whole of Kulu valley is further cut off from the rest of Beas valley by the deep tranverse Larji gorge through Dhaola Dhar and the seclusion has been reflected in the customs and manners of the people of Kulu, being very much different from those of the lower valley.

The most important tributary of the upper Beas is Parvati river which joins it from the east above Bhuntar. The alluvial deposits at the confluence are extensive and the terrace formation is at place 5 kilometres wide. The Parvati rises from the biggest group of glaciers and firns in the upper Beas catchment and naturally brings down very large amount of silt. In its upper reaches are situated numerous thaches which are visited by Gaddis during summer. Large number of pilgrims to Manikaran also visit it. Now-a-days tourists take pleasure in visiting the same for its scenic beauty.

The Larji gorge is a prominent topographical feature of the upper Beas valley which considerably influences the human geography of the valley above and below it. It begins below Aut where the broad terraces of the Kulu valley ends. The altitude of Aut is 994 metres.

The transverse gorge actually begins at Larji three kilometres south of Aut and ends at Pandoh at an altitude of 866 metres, 16 kilometres further down. Between Larji and Pandoh the Beas runs practically straight, cutting through Dhaola Dhar at right angles. Steep cliffs rise on both sides of the river more than a thousand metres. The

gorge was considered as impassable till modern engineering triumphed over nature and a thin twisting road ribbon was practically etched into the cliffs along the river. The gorge ends 10 kilometres above Mandi. Until the road was made, Kulu valley was approached by a mule path from Jogindarnagar passing over the Dhaola Dhar at Bhubbu pass, 3,732 metres high, which is occasionally closed by snowfall during winter. The isolation of the Kulu valley was more pronounced at that time. The motor road, life line through Larji gorge, has resulted in the inflow of articles of luxury from the plains of Punjab. The Gaddis now use match boxes instead of flint and are familiar with electric torch lights and cigarettes.

At Mandi, the Beas gorge gradually opens out. Here the most interesting geomorphological feature is the flood plain of the Suketi Khad, 15 kilometres south of Mandi. It extends about 20 kilometres further south from Bahna to Sundarnagar. At its widest it is eight kilometres broad. The mean altitude above sea level is 774 metres. The Suketi Khad drains out into the Beas through its northern end. In all probability, it is an old lake-bed now filled by alluvium. The plain provides sites for numerous villages and intensive cultivation. Some fruit orchards and market gardens are also found, providing fruit and vegetables to Mandi and Sundarnagar.

A number of small lakes are also found in small depressions higher up in the hills. Of these, Rawalsar at a height of 1,326 metres is worth mentioning. Its seven floating inlands have attracted pilgrims for ages; and ancient temples, a Buddhist monastery and a Sikh Gurdwara are found near it. The floating islands consist of grass and bush roots bound by earth. They are similar to the floating island of Khajiar near Dalhousie or the floating gardens of Dal Lake near Srinagar in Kashmir.

Beyond Mandi the Beas widens out further. Here a number of longitudinal ridges running in an SE-NW direction produce a trellised drainage pattern. The rock-

beds dip towards the south-west resulting in scarp faces towards the mountains and dip slopes towards the plains. The main portions of the rivers also flow in an SE-NW direction, now and then cutting transversely through the ridges. The parallel courses of the streams are progressively higher towards the mountains.

The Uhl, a tributary of the Beas, runs in the uppermost valley between Dhaola Dhar and Ghogar Dhar from NW to SE. The slopes of Dhaola Dhar from the dip slope while Ghogar Dhar presents its scarp face towards the Uhl. It joins the Beas about six kilometres above the Mandi where the Beas cuts a transverse gorge through Ghogar Dhar. In the middle valley, the Rana Khad flows in the same direction below the dip slope of Ghogar Dhar. Its valley is separated from the Beas valley by a lower ridge, which cuts it through a transverse gorge below its junction with the Rana Khad.

Near Jogindarnagar the Uhl flows at a height of 2,000 metres parallel to the Rana Khad which flows just below the town at a height of only 1,000 metres. The two valleys are separated by 2,500 metres high Ghogar Dhar. Moreover, the Uhl and its tributary Thangar Nala are fed by the firm basins and glaciers of Bara Bangahal. These topographic features have been taken as an advantage at the time of the construction of the 48 MW hydel power plant at Jogindarnagar. A dam has been constructed across the Uhl at Barot and the Ghogar Dhar has been pierced by a tunnel. The water is then dropped into the turbines by penstocks descending 1,000 metres. But one disadvantage is the soil erosion owing to overgrazing by flocks of sheep that belongs to the Gaddis. Nearness to the plains has accentuated this problem as marketing of wool and sheep is easy. In Bara Bangahal and Chhota Bangahal below it, there are many "thaches" and "gots" or places where sheep stay at night.

The transverse gorges of the Beas above and below Mandi, as well as the parallel and opposite directions of

the flow of streams, it is important to note, very much resemble the drainage pattern found in the Jura mountains in south-eastern France.

Below Jogindarnagar, the valley gradually flattens out and at Baijnath the plains are reached. From here the snow of Dhaula Dhar is very near indeed. It is a rare site to watch the snow capped range rising straight from the plains of Baijnath. The slightly undulating topography of the area is suited to the growth of tea. The flat portions grow rice and naturally more thickly populated.

#### NOTES

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## The Sindhu-Ganga Water-parting

Among the water-partings of the Indian Sub-continent, perhaps the most important is that lying between the Sindhu basin which drains into the Arabian Sea and the Ganga basin which flows eastwards into the Bay of Bengal. This divide runs roughly along the axis of the Aravalli mountains from south west to north-east, and passes through Delhi situated at a strategic point between the two basins. Delhi is located on the site of old Indraprastha, and was the capital of the Moghuls, as well as the British. The divide runs in the same direction through the Himalaya, between the valleys of the Yamuna and the Sutlej. Here it passes through Simla.

The water-parting runs in a SW-NE direction through Simla, but higher up, it nearly takes an east-west direction till it reaches the border near Nilang. It continues further east into Tibet, often coinciding with Indo-Tibetan border, and ending in the lake which is known as Manasarovar.

This region may be taken to extend from the Siwalik foothills running along Nangal and Chandigarh upto the Indo-Tibetan border between Shipki and Jelukhaga passes. Its northern boundary may be conveniently taken to coincide with the Sutlej river. The southern boundary may be roughly taken to pass through Nahan and Chakrata and then along the uppermost reaches of river Yamuna and crossing over to Jadh Ganga valley and Nilang.

*Natural Landscape :* This part of the Himalaya, which lies within the region under discussion, runs transverse to the grain of the country and hence exhibits, nearly all the facets of Himalayan geology. Moving from the Panjab

upwards to the north-east, one meets the outcrops of the following series—

Upper, Middle and Lower Siwaliks—Pliocene ;  
Subathus—Eocene with patches of Murrees—Miocene  
inside them ;

Krol and Infra-Krol—Carboniferous and Lower  
Mesozoic ;

Jutogh—Pre-Cambrian ;

Older gneisses and quartzites, surrounded by Blainis  
(Carboniferous), near Simla, and a similar pattern  
of outcrops around the granitic Chaur Peak ;

Inliers of Shali series in the Shali window exposed by  
the erosion of Sutlej river—Lower Paleozoic ;

Blainis—Carboniferous ;

Gneisses in a broad belt—Pre-Cambrian ;

Tourmaline granites in Nilang—Primary Igneous ;

Jutogh—Pre-Cambrian ;

Simla Slates—Lower Paleozoic ;

A notable feature of the area is the Krol Thrust, which has considerably narrowed the Siwalik belt here as compared to the area in the Beas valley. In between these two formations there occur the transgressive Subathus. Near Simla and further east are found Jutoghs which consist of old metamorphosed rocks of pre-Cambrian age. Their location in the region may be explained by over-thrusting over the younger Simla slates.

Another notable structure of the region is the Shali window, in the Sutlej valley, where Paleozoic rocks are exposed as inliers, surrounded by Jutoghs. To the south of the window are found Subathus covering Shali limestones.

Lower Paleozoic sediments with little metamorphism occur again in an inner belt around Chakrata and further east. They consist of limestones and quartzites. The limestone peak of Deoban, north of Chakrata, gives the series its name.

Older metamorphosed rocks appear again in the Sutlej

and upper Tons valley. Granite intrusion is also found in the Sutlej valley just north of Kalpa (Chini).

The Tethys Himalaya or the Tibetan zone, generally lies beyond the border of India in this region, though it is well developed in the adjacent Spiti valley to the west.

*Siwalik Zone* : As stated earlier, this zone is not so broad here as in the Beas valley to the west. "The change is relatively abrupt south-east of the Sutlej river, and coincides with a marked southward bulge of the Lower Himalaya, characterized by the Krol Thrust south of Simla."<sup>1</sup>

The lower Siwalik rocks are here called Nahans. They consist of greenish brown and purplish sandstones, with deep brown to green clays. Nahans occur widely but the middle and upper Siwaliks are not prominently displayed.

On the way to Nangal there are 40 metres high beds of old (Pleistocene) alluvium, which give rise to a low badly ravined plateau, with a scarp face cut up and moulded into fantastic landforms. The escarpment is in the process of recession. A good view of this type of topography is obtained from the roof of the famous Gurdwara Anand Sahib built, on the top of the plateau. A few Kilometres west rises the lone circumdenudational peak of Naina Devi, which affords an excellent view point for observing the Siwalik hills.

*Longitudinal Valleys* : Erosional topography is normal and is nowhere inverted as believed by some earlier geologists. Longitudinal "Dun" like valleys are very well marked in the U-shaped bend of the Sutlej at Bhakra and Nangal. It extends to the south-east from Sutlej along another strike valley up to Pinjor which is situated on the western bank of Ghaggar, the mighty river of the past. Pinjor may well be the wind gap through which the waters of the Sutlej flowed into Ghaggar which is now a mere spread of sand and shingle for the major part of the year.

East of Pinjor, the Dun topography is rather confused, the strike valleys being broken up by a number of transverse

streams. On the other hand, the Dun to the west is typical of the region. Here the Himalayan streams descending from the first range through Kasauli and Nalagarh have created huge fans, which have pushed the main longitudinal stream southwards to the edge of the Dun. Here is the last longitudinal ridge named as the Siwalik Range.

Further up there are many other strike valleys developed on both sides of the Sutlej. Two of these to the west enclose the well marked longitudinal Sola Singhi Range. The railway and the road from Kalka to Simla, practically runs along the Sutlej-Yamuna water-parting. Streams to its west join up to form another longitudinal valley, which joins the Sutlej near Bilaspur. But this place is now drowned by the Govind Sagar reservoir, and the beautiful town of old Bilaspur developed on a wide river terrace has also been submerged. The New Bilaspur town is a poor substitute being built on sloping hill sides.

To the east of the water-parting between Dagshai and Simla are the head waters of Giri, a tributary of the Yamuna. It also runs along a longitudinal valley and joins the Yamuna above Paonta. The longitudinal valley continues further east along the Asan as the well-known valley of Dehra Dun. There is a well-marked elbow of river capture, ten kilometres east of Solon and Dagshai. The upper portion of Giri above the elbow must have flown into Ghaggar through a wind gap just east of Dagshai.

*Subathu Tertiary Beds :* From Dharampur, known for its Tuberculosis Sanitarium, a branch road goes to Subathu, a cantonment town. The Eocene Subathu nummulitic rocks are named after this town. They occur as a normal cover over the much older Simla slates. The enormous stratigraphical gap from pre-Cambrian to Eocene is remarkable, but it is an oft repeated phenomena in Western Himalaya. The Subathus consist of "calcite-veined olive shales, green and white sandstones, ferruginous, quartzites

and calcite-veined shelly limestones with nummulites. The shells are mostly broken oysters."<sup>2</sup>

*Krol Belt*: The Krol belt dominates the structural elements of the hills north and east of Subathu. It is named after the impressive Krol Tibba, a peak seen clearly from Solon well-known for its brewery. The belt runs from Simla to Nainital. The oldest and the most characteristic rocks of the Simla Krol belt are the Simla slates.<sup>3</sup> They consist of dark bluish grey slates and some micaceous slates and sandstones. The Krol series consist mainly of sandstones covered by 500 to 1,500 metres thick beds of limestones. Auden has outlined three main thrusts in the Krol belt.<sup>4</sup>

*Jutogh, Jaunsar and Blaini beds*: In Simla area are metamorphosed pre-Cambrian rocks overthrust over the Simla slates. They are named after Jutogh a cantonment area just west of Simla. They are the oldest metamorphosed rocks of this region. They consist of "black carbonaceous garnetiferous phyllites and slates, quartzites and crushed dolomites, with intercalated hornblende schists and gneisses".<sup>5</sup>

Auden describes another series, the Jaunsars above the dislocated Simla slates. These have been further subdivided, the lowest of which, the Mandhalis are characterized by boulder beds. They are said to be older than the well-known Blaini boulder beds.

The Jaunsars are followed by Blaini boulder beds, which seem to transgress over many older formations. They have been correlated with Talchir boulder beds at the base of the Gondwanas. Their tillitic aspect is clear, but the absence of fossils creates difficulties. Supposing their correlations to the Talchirs as correct they are important markers. The Blainis consist of boulder beds, usually covered by limestones. The boulder beds are dark grey to greenish in a matrix of hard clay or quartzitic grits. The boulders are badly assorted. "The Blaini limestones are pink and microcrystalline and probably dolomitic and siliceous."<sup>6</sup>

*Simla Hills* : The physiography of Simla hills is controlled by the watershed, which gradually rises from the plains near Kalka to Simla and beyond upto Narkanda, Bagi and Sungri. While the northern face of this ridge drains into Sutlej, the southern face slopes down to Giri basin upto Bagi and to Tons further up. Beyond Sungri the watershed rises steeply to a snowy peak 5,284 metres high, which is the western end of the snow covered ridge, running east-west, between Baspa and Tons valleys and culminates further east in the Bandarpunch group of peaks, which are actually a southward bulge from this ridge. From Chandigarh one can have a fine view of the first range of the Himalaya, dominated by Kasauli rising 2,000 metres abruptly from the plains. Its two peaks—Monkey Point and Druid's peak present a visual deception. The hump like Druid's peak is higher, but it looks slightly lower than the Monkey Point, which has a sharp conical shape. Just below Kasauli north of it is Garkhal; a narrow col on the watershed over which gravitation breezes blow. Near Dagshai erosion has formed a 16 Kilometres long high ridge called Panchmunda, which passes through Sabathu and Dagshai. It has to be pierced by the hill railway at Barog by a tunnel more than a Kilometre long.

A noteworthy feature of the ridge is a series of fissure springs in a line at the junction of sandstones and shales. A bridle road called "Pipe Line" has been built connecting these springs, which are found practically in a straight line slightly dipping towards Sabathu. The water is collected by a pipe and supplied to neighboring towns. Panchmunda ridge culminates in Panchmunda peak, from where a fine view of the Simla hills is obtained with the snowy Dhaule Dhar range to the north.<sup>7</sup>

Sabathu is situated at the edge of an open basin of a tributary which flows into Sutlej.

The watershed becomes very prominent in Simla, where it is anchored between the two peaks—Prospect Hill and Jako Peak, the highest in Simla. Further up towards

Mashobra and Narkanda the watershed becomes higher, the peak near Narkanda being 3,187, metres high. The declivity on both sides of the watershed is here very steep, and the valley bottoms are far below.

*Chaur Granite* : Forty kilometres south-east of Simla, the granitic peak of Chaur, 3,647 metres high, forms a dominating topographic feature. Between it and Simla runs the upper transverse section of river Giri. To its east is the valley of Tons, an important tributary of the Yamuna. Head streams of the tributaries of these two rivers run in a centrepetal fashion all round the peak. They reveal the intrusive character of the granite. The large thrust mass of the Chaur granite is supposed to be the result of the Almora-Dudatoli thrust sheet.

*Shali Window* : North of Simla the Sutlej gorge is of some importance for revealing the inner structure in the Shali window. West has mapped out this area in detail.<sup>8</sup> Here Shali limestone cover the quartzite base. After some slates are found the Upper Shali limestones covered by white quartzites. Some Eocene Subathu sediments are also preserved in the south, transgressive on the Shali rocks.<sup>9</sup> Very well developed river terraces are found in the Sutlej valley, where villages and agricultural fields are located. A tourist attraction is provided by hot water oozing out of sands near the bank of Sutlej at Tattapani. Further up the Tibetan Highway follows the valley.

*Kalpa and Baspa Valley* : In the higher portions of the region is found the upper part of the Sutlej valley in the newly formed district of Kinnaur. This area is glaciated and shows features like truncated spurs, hanging valleys and U-shaped gorges. The most interesting part of this portion of the valley is the Baspa valley which is broad glaciated valley. In it above Chitkul are found clear signs of recent retreat of the glaciers. R. Bhattacharya noted a number of such features.<sup>10</sup> Of special interest are transverse dams of boulder clay across the valley, which are similar to those found by the author in the Alakananda valley and

above Sheshnag in Kashmir. They are obviously old terminal moraines indicating recent recession of glaciers. Village Sangla is situated on one such terminal moraine. The flat round area behind it was a temporary lake now drained off. The lowest terminal moraine is about three kilometres below, which has now been cut through by Baspa, where it plunges into the gorge below, revealing huge cliffs of boulder clay on both sides. The flat basin between these two terminal moraines is obviously the bed of another lake. Fluvio-glacial terraces occur on both sides of the river. Ottley has described the Baspa valley as broad and flat and bounded by cliffs of brown conglomerates. He further mentions the occurrence of evidence of a glacier having reached below Chitkul.<sup>11</sup> The enclosing cliffs were obviously formed by ancient giant glacier.

*Nela Pass* : Among other parts of the higher portions of the water-parting is the Jadh Ganga valley around Nelang. Below it, the Bhagirathi gorge above Dharali is separated from the Baspa valley by the Nela pass. Nela pass or Chhot Khaga lies on the Sindhu-Ganga water-parting, being here between Baspa valley and Bhagirathi. The pass is about 5,000 metres high. To reach the pass one has to climb over hard ice, till at 4,700 metres a "razor back lateral moraine is reached, over-looking a fine glacial amphitheatre. Two big much crevassed glaciers come down from the north and feed a glacier basin two kilometres across and reaching down to 4,200 metres. On the Baspa side there is another glacier covered by black moraines near the shout."<sup>12</sup> The razor sharp lateral moraine indicates that it is being eroded at present and is not being fed by morainic material. This is due to the shrinking of the glacier.

*Jadh Ganga Valley* : Below Bhaironghati the Bhagirathi is joined by Jadh Ganga from the north, both the rivers cutting fantastic gorges in the tourmaline-granite mass of the central axis of the Himalaya. The Jadh Ganga valley further north opens out around Nelang village situated on



an extensive talus fan. "In a gully opposite the village the rocks change from steep granite slabs to almost horizontal rocks; and from there onwards the scenery is typically Tibetan. Here the talus fans give way to the flats of Tsonam camping ground at 4,006 metres. Here Bharal ( mountain wild sheep ) come to lick salt fearlessly. Sixteen kilometres further above are found rotten shales and grassy flats among red brown hills.<sup>1</sup>

*Upper Tons Basin :* There are many difficult high passes in this basin which are all on the water parting. The most important of these is Shinka Pass connecting the Jaunsar-Bawar region in the Tons valley with Chitkul in the Baspa valley. The track over Shinka Pass descends to the south to Rari, Goichran and Tiuni. Another route starts from Sangla in Baspa valley over Nalgan Pass to Katol on the Rupin river, joining with the previous route at Goichrar.

This snow-y water-shed is drained to the south by the tributaries of Pabar and Tons, both of which join at Tiuni. All these high valleys once sheltered large glacier, which have now melted away, leaving masses of glacial till in the valleys which are dominated by huge truncated cliffs, hanging valleys, amphitheatres and so forth. One of these is Harki Dun, a high secluded glaciated valley dominated by the Bandarpunch group to its south, north and east.

*Yamuna Valley :* Yamuna is a major river of the Ganga Basin, and it may be considered as the last valley to the east, limiting the Sindhu-Ganga watershed. The Yamuna rises from waterfalls thundering down from the southern rock cliffs descending from the southern face of Bandarpunch.<sup>14</sup> There is no glacier worth the name at present in this valley, but there are ample signs of the existence of past gigantic glacier, which was formed by a system of smaller glaciers near Yamunotri and was joined by large tributary glaciers near Kharsali and Beef villagers. The absence of glaciers is responsible for very little

removal of glacial debris from the area around Kharsali and Phul Chatti. Kharsali stands upon a large plain made up of glacial debris which presents a 100 metres high and 3 Kilometres long scarp of boulder clay on the eastern bank of the river. There are other such platforms. Up to Yamuna Chatti, there are giant truncated cliffs and waterfalls. Further down appear very well developed river terraces on which are located many big villages, such as Kutnaur and Barkot,

*Jaunsar-Bawar* : This region is limited roughly between the Tonk and the Yamuna, in their lower portions in the Himalaya, both of them joining at Kalsi, below which the Yamuna enters the plains. The most conspicuous feature is a crescent shaped ridge which passes in the middle of the region.<sup>15</sup>

### Natural Vegetation and Soils

Natural vegetation is greatly controlled by altitude and to some extent by other aspects. It follows the pattern of other portions of western Himalaya. The agriculture, land-use etc. has already been discussed in a previous chapter thus only the essential points will be touched here.

The foot-hill portions from Nangal to Nahan up to a height of 1,000 metres are generally covered with tropical deciduous jungle, where one meets a greater number of xerophytic plants, including trees, such as acacia and thorny bushes. There are rank grasses and bamboos also. The vegetational cover becomes dense as one rises in altitude.

Between 1,000 to 2,000 metres the hills are very nearly exclusively covered by Chir pine (*Pinus longifolia*). One notices deodars only at a higher level. Pines impart a light green-brown colour to the scene up to just below Simla in Simla hills. The whole of Kasauli hill, Dharampur, Panchmunda ridge, Solon, Chail and even Taradevi hill only eight kilometres from Simla are covered by dense forests of Chir pines. Sabathu is at lower level, and

valleys below it have tropical vegetation. At this level pines are also found in the Yamuna, Tons and Giri valleys. In Yamuna valley the Chir pines occur up to Sayana Chatti. They are very dense at Barkot and Gangani.

Above 2,000 metres oaks, beeches, walnuts, chestnuts (pangar) and a few rhododendron trees are found. Further up are a variety of firs and deodars. They cover the hill slopes around Simla, Mashobra and Narkanda. They are again found around Chakrata and above Hanuman Chatti in Yamunotri valley. In the upper Baspa valley are found many walnuts and willows. Wild apricots and grapes are also found all over Kinnaur.

Above 3,000 metres appear patches of grass land and they increase in size till the tree line is reached near 4,000 metres. Near here occur birches and bush rhododendrons. Further up occur Alpine grass lands, flowering shrubs and thick-level plants. Here one may also find Guggul and a variety of medicinal herbs.

Soils are usually rich in humus, specially among oak forests, where brown forest soils occur. In steeper slopes soils are immature. Along the river beds are found ribbons of gravelly soils. River terraces consist of alluvium, some times mixed with boulders. Pines and conifers tend to produce poor acidic soils, which develop into podzols higher up. Glacial soils are common near the tree-line and above. Near the snow-line the soils are immature.

### Cultural Landscape

Though natural landscape predominates in the rugged mountainous terrain constituting this region, imprints of cultural landscape are not to be neglected. Mountain villages, their colourful inhabitants, cultivated fields, orchards, sinuous road and rail tracks and even a few industrial units together with some fine hill towns are elements of cultural landscape. These elements are concentrated in what has been termed the "Optimum belt" in the Himalaya. This belt lies between 1,000 and 2,500 metres.<sup>16</sup>

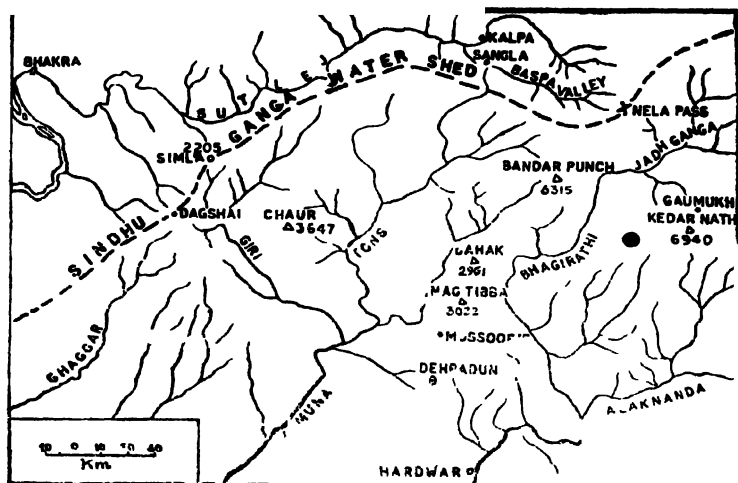
**Simla Hills :** This hilly area, being nearest to Delhi, was chosen by the British Government to locate a summer Capital for India and developed it for keeping white soldiers in its cool heights in summer. They created a number of towns all over the Simla hills.

Kasauli stands on the first ridge of the Himalaya which has gained a good height to be cool in summer. Earlier it was reached by a 15 kilometre bridle path from Kalka. Now there is good motorable road, bifurcating from the Kalka-Simla road. Nearly all the towns of Simla hills have a cantonment and Kasauli has one. Due to its cool climate, refrigeration being unknown, it was decided to establish a unit here to make and store vaccines for mad dog bite. It developed into a hospital for hydrophobia and other communicable diseases, and was named after Pasteur. It was the only one of its kind in India at that time. Another research institute was also established here to produce a variety of other preventive vaccines.

Near it is Sanawar, on a hill peak, where a school for white children was established. Further a T. B. Sanatorium was developed at Dharampur, and was one of the biggest of its kind at that time. It was served by the hill railway, as well as the motor road to Simla. From here a branch road 20 kilometres long descends to Sabathu. Among the Chir pines of this area are a large number of villages and hamlets, and the people produced food grains in many terraced fields. Maize is an important summer crop. Other millets are also grown. During the rabi season, though snow falls near Kasauli, wheat and barley are grown. Vegetables, chillies, lemons and ginger are grown for the town markets. The villagers also keep cattle and goats to supply milk and meat to Kasauli and other towns. A few walnut and apricot trees are also found near the villages. The nuts and fruits have a good market. In recent years the production of such commodities has increased.

The Simla road now ascends over the Panchmunda

ridge and passes through Dagshai another cantonment set amidst pine forests. The railway here burrows under the Panchmunda ridge, and comes out on the other side at Barog. Incidentally the railway track is a marvel of engineering. It passes through about 100 tunnels, big and small. The triple zigzag and tunnel between Jabli and Dharampur is also worth-mentioning.



Map 12

All over the Simla hills the strange custom of "Nula" is practised. This consists of making a baby sleep by allowing cold spring water to fall on top of its scalp to benumb its senses. A small sleeping place is made of pine needle, and the water is dropped through a bamboo pipe or twisted leaf in such a manner, that after dropping over the head, it rolls away into the stream below. Women make their babies sleep in this manner when they go for work in the fields. Sometimes grown-up people also enjoy a nap on summer days by Nula. The custom specially prevails on the slopes of Panchmunda ridge.

Beyond this ridge the scene changes. The second biggest town of the Simla hills Solon spreads here on a gentle slope. It has been famous for its brewery since the

times of the British. It is also a market for the produce of the surrounding hills. The chir pines in this part are fewer and there are more cultivated fields. The hills have a bare aspect. Walnuts are being increasingly grown. Another commodity is "Anar Dana" made by raw, sour seeds of a variety of pomegranate. It is much used by the Punjabi as a condiment. Its "Churan" is very tasteful.

Beyond Solon and Solon brewery is Kandaghat on the railway and the road to Simla. From here a road bifurcates to Chail, the previous summer capital of Patiala and famous for its cricket ground in the mountains, a favourite sport of the previous Maharaja.

Nearby Simla there are a number of cantonments, such as at Jutogh and Simla itself. Eight kilometres before Simla is reached is the peak of Taradevi covered by a dense forest of Chir pines. On it is situated a temple as well as a well-managed dairy farm producing dairy products and meat ( both mutton and pork ) for Simla.

Simla is the largest hill town in the Himalaya. It boasts of fine buildings built by the British, such as the Viceregal lodge, now changed into a Research Institute. There was a great influx of Panjabi refugees in Simla, specially the rich class, after the partition of the country. So to-day, besides the old race course at Arfandale and the skating rink, many new hotels and restaurants have sprung up. There are also a large number of schools old and new. There are some very fashionable shops. New life has been infused by the refugees, and Simla is a bustling town. It is thronged by visitors from the plains in summer. Simla is now an important road centre. The new highway to the Tibetan border at Shipki, passes through Simla. A road goes to the west to Mandi in the Beas valley, and another to the east to Chakrata and Mussorrie. It is now being developed as an east-west lateral highway in the Himalaya. A hill railway ascends to Simla from Kalka.

*Upper Sutlej and Baspa valley :* Though the exceedingly beautiful natural scene in this valley comes first to the eye,

the people, their houses and their fruit gardens are also very attractive. The new district of Kinnaur, with its capital at Kalpa ( Chini ) cover this region. The people of this district are perhaps the Kinnaras as described by Kalidasa as a race, known for their beauty.

The valley is now being developed as a fruit growing area. Apple orchards at Kotgarh in Mahasu district are supplying this fruit to Simla and the plains. According to Kaushik, Kinnaur is famous for growing grapes which are used even for making wine. In the lower altitudes soft temperate fruits like apricots, peaches pears and plums are being grown. Higher up are found apple orchards. With some effort the valley may become an important producer of temperate fruits. It may further be developed for growing cherries, straw berries and so forth. Excess fruit could be converted to squashes, jams and jellies. The whole area above Simla is also a big producer of potatoes.

The valley has trees of walnuts, chilghoza ( neoza ) and other nuts. Almonds and Pistachis can also be developed. Walnuts find a good market in Simla. Fine grade walnuts, Chestnuts, almonds and Chilghozas, which sell at very high prices have a bright prospect for development.<sup>17</sup> In Kinnaur grapes are used for making "Angoori" a kind of alcoholic drink.

In the high valleys and alpine grasslands, one only finds scattered fields of barley and phabar. There are a few villages of semi-nomadic people, who keep sheep, goats and cattle, which are often crosses between yaks and Indian cows. They graze their live-stock in high valleys during summer and descend to the warm valleys during winter when the region is under deep snow.

The Kinnaras are very colourful people, with Persian features. They wear gowns of woollen clothing and coloured caps. Men and women dress alike. They are also fond of locating their villages on steep spur tops. Village Kamru in Baspa is a good example of such

location. The old village of Chini is also on a steep spur. Village Sangla and Chini have a central square, where the village temples are situated. There are a series of water mills in Sangla in Baspa on a glacial water course. Women carry water in pitchers in wicker baskets, made from willows.

*Jadh Ganga Valley* : The valley lies north of the Central axis of the Himalaya. So there is a marked change in the culture of these people. The Jadh<sup>18</sup> who inhabit this place have nomadic habits. They keep flocks of sheep, a few goats, ponies and cattle. Sheep dogs, always accompany them in their movement. Their houses are very strongly built. They cultivate Phabar and barley like the people of Baspa. They move down with their flocks in winter to warmer Bhagirathi valley below Dharasu. They have two main villages. The upper village is Nilang situated on a huge talus fan. Lower down they have the next village at Barari near Harshil. Their houses are surrounded by stone fences, so that sheep flocks can be kept inside.

Another type of people of this valley are Bhots, who are more akin to Tibetans. They are shepherds-cum-traders. But their trading has diminished as they cannot go across the border now. The Bhots have in some cases mixed with Jadh<sup>s</sup>.

*Yamuna Valley* : In the upper portion of this valley live Chauhan and Panwar Rajputs. They grow potatoes, phabar or phapra and Marcha (Ramdans). They also grow some apples. There are two large villages here—one is Kharsali situated on a glacial platform and the other Beef which is an ancient amphitheatre. In the lower part of the valley are extensive river terraces, where villages like Barkot and Kutnaur are situated. The villages spreading conveniently on flat grounds are typical of the upper Yamuna valley. Some villages are also found in valley bottoms or river junction. Higher villages are located on gentler slopes above the truncated spur cliffs, on the shoulders of



**U-shaped valleys.** In autumn the red colour of *marcha* fields and the yellow of Phapra, imparts a beauty to the scene.

Men usually tend the flocks of sheep. They also go to Barkot with their sheep laden with potatoes in small bags (Panch), to sell them. Women work in the field. They harvest crops, and collect fodder for the live-stock. In autumn they are seen in the evening wending their way to the villages overladen with harvested crops or grass.

The people are religious. In big villages, like Beef and Kharsali, a large temple in mountain style of architecture dominates the scene.

Up in the forests live Gujars with their buffaloes, who migrate to the plains in winter.

*Jaunsar-Bawar* : This mountainous tract lying between the lower Yamuna and the Tons rivers is not so remote from the plains of India, but not being on a well-known pilgrim route or trade highway, it has remained secluded. The only contact with civilization has been provided by the establishment of a big cantonment at Chakrata at a height of 2,400 metres by the British. According to Dr. A. K. Tewari<sup>13</sup>, "isolation has preserved a fossil culture of ancient times here, and the practice of fraternal polyandry is associated with antiquity. The people still follow the age-old custom and superstitions."

Fraternal polyandry has its example in the Mahabharata, and the people here claim to have preserved that age-old custom. In the present times, however, it has created a vicious circle. It has reduced fertility in womenfolk and has helped in augmenting the abnormality in sex relation, so that the female population are on the decrease, which again forces polyandry to continue. At one time it was thought, that it will lead to the extinctions of this race.

Unlike Yamuna valley the villages of Jaunsar-Bawar are small and the population is dispersed in hamlets. "A village in Jaunsar-Bawar is a self-sufficient unit and all requirements of food, utensils, cloth and fuel are locally supplied. People hardly need move out and this increases

their isolation and primitiveness and preserve their age-old customs.”<sup>20</sup> People consume a lot of animal food. They maintain cows, goat and sheep. Some seminomadic Gujars also inhabit in the higher forest regions. They keep buffaloes.

Fruit trees are grown in small orchards, apples higher up and soft fruits such as plums, peaches and apricots lower. Walnuts are also found. Their production could be much increased. Paddy fields are found in terraced valley bottom where good water supply can be maintained by a system of “kuls” or canals. Higher slopes are also terraced, not so evenly for growing maize which is an important cereal. Millets are grown in thinner, poorer soils. One of them is “Chaulai.” Potatoes become important in cooler and higher areas. Too much potatoes growing leads to soil erosion. Wheat is a winter crop in lower regions, but higher up it is sown in December and sprouts very slowly due to low temperature. Moisture is supplied by the melting of snow. In spring or early summer it grows and ripens quickly to be harvested.

In the interior in Bawar another millet called “Maduwa” becomes more important. Country liquor is made from its flour; wheat and barley are winter crops which follow rice and maize respectively.

The people of Hanol, a small village on the river Tons in the interior are mainly “Baigis” or dancers who serve the famous temple of Mahasu Deota. They also consume much fish. A festival called “Mach Mond” is celebrated, when fish are caught by poisoning them by the powdered bark of a tree called “Timur.”<sup>21</sup>

*Higher Valleys of Tons Rupin, Pabar and Giri :* All these higher valleys are nearer to the water-parting. They are all very high, cold and glaciated, they are situated in remote inaccessible places and are largely forested and thinly populated by semi-nomadic people, who roam with their flocks of sheep and goats, among high alpine pastures during summer, and move down during winters. The

people of these valleys have little contact with the outside world.

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## Upper Yamuna Valley

Rising below Bandarpunch ( 6,315 metres ) in the Central Himalaya, river Yamuna descends rapidly to the plains of the Dun valley, at Kalsi in a distance of about 120 Kilometres. As usual with other rivers of this part of the Himalaya, the lower portion of this length above Kalsi is a forested, V-shaped gorge for about 30 kilometres. From here upwards are found well developed river terraces, where villages are located.

A new road is being constructed up the river from near Kalsi on the Dehra Dun-Chakrata road to Barkot, where it will meet the road from Dharasu on the Bhagirathi road from Rishikesh to Uttarkashi, Jangla and Nilang.

Barkot is fast developing into a road centre and a market. Another road from it goes across the Yamuna westward to Parola and beyond in Jaunsar-Bawar. The settlement of Barkot spreads over a large two-tier terrace on the left bank of Yamuna. Barkot is already an important potato market. It has a school and a hospital.

The water-shed ridge separating the Yamuna valley from Bhagirathi valley rises steeply above Barkot to about 2,500 metres. The road from Dharasu climbs along the Khurmola Gad ( small stream ), a tributary of Bhagirathi through a broad open valley, full of river terraces, intensively cultivated, growing rice, wheat and millets.

The water-shed ridge, here called Rani Parvat, is dominated by the conical forest peak, named Bahak, 2,961 metres high above sea level. The whole ridge is covered by a forest of Chir pines ( *Pinus longifolia* ), from which resin is tapped. The road ascends the ridge in three sweeping zigzags, to climb down steeply again on the other

side to Barkot in the Yamuna valley. Fine views of Bandarpunch and adjacent snow ranges are obtained from points on this road.

The motor road has been opened for passenger bus traffic up to Gangani, six kilometres further up from Barkot, and it is nearly ready for another 10 kilometres. Only two or three bridges and a few small sections have to be completed to make the road fully motorable up to Hanuman Chatti, from where Yamunotri will be only 13 kilometres away, and its extension up to Beef village will have no difficulty.

The extension of the road has proved a great stimulant to the lethargic people of the valley. They have realized the value of cash and are eagerly increasing the production of potatoes, which are moved to Barkot, where plain's merchants gather to purchase them. Much of this commodity is carried down by mule caravans. Even flocks of sheep and goats are mobilized to carry potatoes in small bags called "*phanch*". There are apple orchards in Kharsali, the last village in the valley. They are sold to pilgrims and tourists visiting Yamunotri. Their production could easily be increased. A greater variety of fruits such as apricots, pears and peaches could also be grown. Nut-bearing trees, such as walnuts of variety could be planted. Wild walnuts are already there above Sayana Chatti. *Chillu* or wild apricot trees are also found here and there.

Agents have arrived in the mountains to collect herbs, such as *Guggul* (for incense), *Mamiri*, *Ratanjot* and so forth, which are found above 4,000 metres. There is scope for research and development of these rare herbs.

Beyond Yamuna Chatti the scene changes rapidly. Sheer vertical rock cliffs appear on both sides of the valley. Over them water-falls cascade down into the valley below. No doubt these are truncated spurs and hanging valleys. From the bottom of the valley one is unable to view these glacial forms clearly. At a few places now appear deposits

of glacial till through which the road passes. Just beyond Yamuna Chatti appears the first rock cliff produced by truncation. Below it the river has cut a cave by lateral corrosion. It is used as a camping place by Chauhans and Panwars of Rajput stock who come with flocks of sheep and goats, carrying "*phanches*" filled with potatoes while moving down and rice, wheat, salt, etc. while going up.

Here in the river bed is a raised platform made up of water rounded boulders and silt. Far away from here down the valley, one notes a huge platform, 300 metres above the valley below it, but at the same level as this platform. Upon it is located a large village named Kutnaur. It is thus a high river terrace. Another village Dundiya Gaon is situated on a similar river terrace on a side tributary coming down from Rani Parvat.

The boulder deposits sometimes are confusing. While below Yamuna Chatti they are usually water rounded, but just above and below it are found sub-angular boulders showing a morainic origin. This is explained by the fact that some of these have been brought by the river during floods from above. The retreat and advance of the ancient glacier at this place, a number of times, is obviously another cause. The glaciated boulders and their deposits clinging to the sides of the valley, may have been brought by this early glacier.

At present there is no glacier worth the name in the upper Yamuna valley. But the present topography shows clear signs of an earlier giant glacier. It definitely came down up to Yamuna Chatti in the past. It was formed by the junction of a number of smaller glaciers descending from the Bandarpunch group of peaks. At Kharsali it was joined by a large glacier from the east. This combined ancient glacier had huge dimensions. We may call it the "Yamunotri glacier."

After the Yamunotri glacier melted away, Yamuna had much less supply of snow-melt water as compared to

Bhagirathi and Alakananda rivers. This has resulted in large accumulations of glacial till, which nearly choke the valley up to Phul Chatti.

As one advances further above Sayana Chatti, larger deposits of glacial till are noted. The natural vegetation gradually changes. Oaks take the place of Chir Pines. There are beaches, walnuts, chestnuts (Pangar) and many varieties of *Quercus*. Rhododendrons appear here and there. Further up are seen deodars, spruce and fir trees. Timber is being tapped from these forests, specially between Hanuman Chatti and Phul Chatti. Timber logs are floated down the river. Wire line are also being used, along which timber shoots down from the high forest above to stacks near the river.

All along the valley the rocks met within road sections are metamorphosed and crystalline. Quartzites are very common. White quartzites containing a large proportion of quartz are found at many places. They are stained green here and there, due to the presence of copper salts. Among crystalline rocks are schists and gneisses.

Higher up cultivation also changes. Ramdana or 'marcha' is a common millet. Its red colour stands out amidst the dark green of forests. Fields around villages are all red in the months of September and October. Another millet which grows in these high altitudes is 'phabar'. It is a double purpose crop. While its grains are used as food, the stalk and leaves provide fodder. After the rains in September and October women are busy in harvesting phabar. Laden with them they are seen coming to their homes in the evening. They also cut and bring grass. All these are stuffed and piled up wherever there is space, to provide fodder to cattle and sheep in winter, when deep snow covers the region.

The scene above Phul Chatti is dominated by glacial topography. Just opposite to it stands a prominent cliff of boulder clay, with a flat top above. Just beyond, the Yamana and one of its left bank tributary Unta Gad have

cut right through the thick ground moraine deposit and sawed into quartzite rocks in the bottom producing deep, narrow gorges. Beyond these gorges is the large village of Beef situated in a big amphitheatre, a work of the past glaciers. Its houses use timber and stone for construction, and are solidly built to keep warm in the cold winter. A large temple stands in the centre. The red marcha and the yellow phabar fields all around give colour to the scene.

Across the river is a 100 metres high and two kilometres long cliff of glacial till, with a huge platform eight kilometres long on top. This fantastically large deposit of glacial material was deposited at the edge of the amphitheatre by big glaciers which came from the east. Their U-shaped forms can be seen spreading beyond towards high ranges. Yamuna and its tributaries are too small to wash away this huge deposit. This platform at level of 2,600 metres, provides a good site for the large village of Kharsah, which now grows great quantities of potatoes. The men of Kharsah carry them to Barkot in mule caravans or by flocks of sheep and goats.

There are some apple orchards in Kharsali. More orchards could be grown, because, as the road extends further, it will be easier to send them to the plains, where they will be in great demand.

Semi-nomadic Gujars live during summer in high mountain forests. They keep herds of buffaloes. They are Muslims and have migrated here from Kashmir and Punjab. The Hindus of the valleys below purchase butter and 'ghee' from them. They move down with their buffaloes to the plains of Rishikesh during winter. They rarely sell milk in the mountains. By the end of October they all reach the plains.

Beyond Beef is Janki Chatti from where the temple of Yamunotri is six steep kilometres away.

Near the Chatti is a hot spring which gives out warm water. It gives a reddish stain on the rocks and has a



saltish taste. The hot spring at Yamunotri gives the same stain. The water is useful for bathing and washing. Its chemical and radio-active properties could be investigated.

Entering the gorge, one is hemmed in on all sides by towering forested cliffs topped by serrated ridges, bare in autumn, but snowed up for not less than eight months. A number of tributary gorges join it. But all of them are narrow. Ultimately the gorge reaches the steep cliff face of Bandarpunch, the snow cover of which seems much less, due to the angle of vision having an elevation of not less than 70 degrees. Waterfalls thunder down from above into the gorges below. There may be half a dozen such water-falls. Narrow U-shaped gorges cut into the great cliffs of Bandarpunch. There are no glaciers at present. It may now be imagined that these narrow gorges were excavated by a number of small glaciers in the closing phases of Pleistocene glaciation. Earlier there was a bigger glacier at a higher level, which was responsible for the creation of the tremendous cliffs of Bandarpunch. These glaciers joined into one huge glacier at Beef. The concentration of glaciers have naturally produced the massive till deposits all round.

The temple of Yamunotri is tucked in a corner of a great rock cliff, and just from below it rushes out a hot spring, almost with the force of a geyser. Its temperature is about 90°C, which is the point of ebullition at this altitude. Rice and potatoes are cooked in it by pilgrims. It is collected in a tank after being dropped through cold air. Here pilgrims take a refreshing dip in the hot water.

## Uttarakhand

Geomorphology in the Himalaya plays very important part in moulding human activities. It is more so in steep and rugged landscapes, where river terraces, alluvium filled basins and the degree of slope together with altitude determine land use. They control the pattern of routes and the flow and intermixture of culture.<sup>1</sup>

*Altitudinal zones of occupance* :<sup>2</sup> Uttarakhand region constitutes mainly of the valleys of the four source rivers of the Ganga, namely Bhagirathi, Mondakini, Alakananda and Pindar. They join at Dev Prayag to form the Ganga.

The highest zone is approximately above 4,000 metres. Some Himalayan giant peaks, such as Kamet and Nanda-devi are situated here. Shivling and Nilkanth are examples of awe-inspiring horned peaks surpassing Matterhorn in grandeur. The peaks are generally surrounded by steep rock cliffs flanking glaciers between them. They resulted from truncation by Pleistocene giant glaciers. Frost action is supreme all over the region. The present glaciers ride over the ground moraines of the past giants. Today they are shrinking and decaying. This zone is not inhabited by man. Occasionally shepherds visit some places with flocks of sheep. There are a few difficult routes.

Between 4,000 and 3,000 metres the valleys and amphitheaters are choked by Pleistocene glacial till which is being slowly removed by rivers. Alpine meadows provide pastures for semi-nomadic tribes. Barley, "Phabar" and

wheat is cultivated. Holy shrines situated in this zone attract thousands of pilgrims, who are a source of income to the people.

Between 3,000 to 2,000 metres occur tremendous gorges. Truncated spurs rise steeply to dizzy heights. Over them descend waterfalls from hanging valleys. The present rivers are digging a V in the past U-form. Habitations and communication lines are along valley bottoms. Potatoes, paddy, wheat, madhu and chua are cultivated. There are dense temperate forests of oak and pine. The topography is extremely rugged.

Between 2,000 and 1,000 metres river terraces are very well developed. The valleys are open. Terraces provide lane for intensive cultivation of paddy, wheat, madhu and maize. Much potato is raised. This zone has an optimum density of population.

Below 1,000 metres the valleys again form deep gorges among tropical rain forests. Habitations are scattered and few. The climate is moist, warm and unhealthy. Wild animals inhabit the jungles.

*Source rivers :* Below Dev Prayag where the Bhagirathi and the Alakananda meet the river acquires the name Ganga, which emerges from the mountains at Rishikesh, flows through the Dun and cuts across the Siwalik range at Hardwar.

Alakananda is the main tributary of Bhagirathi. Another source river of Ganga is Mandakini which rises near Kedarnath temples and joins Alakananda at Rudra Prayag. The fourth source river Pindar Ganga rises from Pindari Glacier and joins the Alakananda at Karna Prayag. The fifth source river may be taken as Dhaul Ganga, which joins Alakananda at Vishnu Prayag below Joshimath. There are numerous other source rivers, all rising in the snowy ranges of Uttarakhand, such as Jadh Ganga or Jahnvi rising in Nilang tract, and the Saraswati which rises near Mana pass and joins Alakananda at Keshav Prayag below Mana village. Two other tributaries

of Alakananda are the Bhyundar Ganga or the valley of flowers and Bifahi Ganga.

### **Morpho-Ecology of the Upper Bhagirathi Valley.**

River Bhagirathi is considered to be the main source of the river Ganga.<sup>3</sup> Between Tehri and Bhatwari the river generally flows in a comparatively broad open form except above Dharasu, where it cuts a deep gorge through quartzites.

Near Tehri it forms extensive river terraces, which are well cultivated and fairly well populated. The location of Tehri, the capital of the past mountain kingdom is based upon the occurrence of these terraces. Four sets of terrace levels are clearly visible. But sometimes there are more.

A feature of the valley is the meandering course of the river which are clearly incised. A beautiful incised meander, complete with a meander core occurs at Malidewal.<sup>4</sup> Even in the core there are three terrace levels. These clearly indicate the intermitent rise in the Himalaya.

The higher slopes forming the interfluvium between Bhagirathi and Yamuna are usually forested above 2,000 metres. Among these forests and above them live nomadic Gujars, with herds of buffaloes which have already been mentioned in Chapter 13.

Paddy grows extensively as a summer crop on the terraced fields. Other crops are maize and oil seeds. Late winter and early summer crops are wheat and barley. Millets are grown in summer.

The last expanse of natural terraces occurs near Bhatwari, where gorge scenery is also evident at places.

But a few miles beyond Bhatwari, we meet a deep gorge through which the river rushes down, very often in rapids. On both sides rise stupendous truncated spurs. The rocks are usually gneisses. Waterfalls cascade down into the gorge from hanging valleys, which alternate with truncated spurs. Gangnani is situated inside this gorge.

A hot spring is found here. Above Gangnani there are marked rapids in the river, which may be considered as clear breaks in the longitudinal profile of the river. At least two such rapids are marked.

Clear cut breaks in the longitudinal profiles of Himalayan rivers are found elsewhere, such as in the East Liddar valley at two places<sup>5</sup>—Mandakini at Son Prayag<sup>6</sup> and Beas above Bashisht<sup>7</sup>. They are explained by the joining of tributary glaciers of the past. The rapid in Bhagirathi is also observed below its junction with a tributary above Gangnani.

A clear cut V is being eroded into the previous V-shape. The same valley cross-section is very common in the Himalayan rivers at about the same altitude, such as of Alaknanda below Pandukeshwar.<sup>8</sup>

Beyond Suki the scene suddenly changes. There is a broad flat basin below Jhala, about three kilometres broad. It is filled with sand and gravel over which the river flows in a braided course. This is definitely a rock basin excavated by the past glacier.

The open aspect of this part of the valley has led to the development of agriculture. Apples were introduced at Harshil by a British ex-soldier settler, and now there are many flourishing apple gardens. Large apricot trees grow wild. There are wild walnuts also. The altitude is about 3,000 metres. Horticulture could be developed here much more. Cabbages and beans are also grown. Curiously they supply "Phalahar" for the Gods, and perhaps this is the incentive. Otherwise the dwellers of Garhwal hills do not bother much about growing fruits and vegetables. Harshil and its neighbouring settlement Bagori is also serving as a staging ground for the semi-nomadic "Jadhs" of the Jadh Ganga Valley. Their main wealth consists of flocks of sheep, with some mountain goats. Their permanent village Bagori is built of stones. Nearly every house has a large fenced court-yard for keeping animals. A few horses and sheep-dogs are also kept. Blankets are woven

here. Sheep and goats move down to warm valley bottoms during winter and graze in high alpine meadows below the snow line during summer.

Among these nomads are a sprinkling of Gaddis, conspicuous by the rope round their waist.<sup>9</sup> Some Bhot nomads who are akin to Tibetans have also opted to stay within India after the development of strained relation with the Chinese. They also own flocks of sheep. Some Bhot women have taken to weaving Punjabi dress. Some of them are very rich and they employ Jadhs for tending their flocks. Old, infirm and children among Jadhs stay during winter in permanent villages like Bagori. Some Jadhs have inter-married among Bhots and have thus lost their caste, according to Garhwalis of the lower valley.

There is a sudden change of scenery at Jangla, beyond which the Bhagirathi cuts an awe-inspiring gorge through tourmaline granites constituting the central axis of the Himalaya. Here the blue waters of Jadh Ganga meet the Bhagirathi, amidst the most spectacular granitic scenery. Both the rivers are in all probability antecedent to the rise of the Himalaya.

The end of the Bhagirathi valley is blocked by two kilometres wide front of the 30 kilometres long Gangotri glacier.<sup>10</sup> Over it rise the glistening snowy pyramids of Bhagirath Parvat and Shivling. The later is a perfect example of a horned peak. It stands right on top of Gaumukh, the arched snow cavern through which the swirling grey waters of Bhagirathi gush out.

It seems as if the Ganga is coming out from the "Jata" of Shankar. And hermits could make the people believe that the straightness of the granite gorge of the Bhagirathi could have been the work of Bhagirath, whom Ganga followed as he went ahead blowing his conch shell.

#### Alakananda Valley

River Alakananda, a major tributary of the Ganga, rises from the twin glaciers Bhagirath Kharak and Sato-

panth, which take their rise from the eastern slopes of the Chaukhamba massif and its satellite peaks, forming the snow-parting between the Gangotri group of glaciers to the west and the Bhagirath group to the east. The young river skirting the Neelakantha and Narayan Parvat from the north and east, flows past the holy shrine of Badrinath, and collecting the waters of Khira Ganga, Bhyundar Ganga ( Valley of Flowers ), Dhauli Ganga, Nandakini, Pindar Ganga and Mandakini and joins the Bhagirathi at Dev Prayag, to form the Ganga, which emerges out of the ranges of the Himalaya at Rishikesh.<sup>11</sup>

This portion of the river from Rishikesh to Dev Prayag passes all along through dense tropical forests covering steep slopes on both sides of the valley. Foaming over boulders, the river meanders through interlocking spurs in a gorge cut deep in the towering ranges.

This condition continues above Dev Prayag in the Alakananda valley, up to a few miles below Kirtinagar. Further up the valley broadens out. Large terraces are developed on both sides of the river, which are covered by cultivated fields and dotted by farm houses and dwellings concentrated into villages here and there. This is in marked contrast to the patchy habitations in forest clearings in the gorge below Kirtinagar around Vyasi.

The terraces open out into a big intermontane plain at Srinagar. Alakananda is incised in the plain some 30 metres. Srinagar has grown into a big route centre where buses and trucks have to stop at night, due to the prevailing gate system and one way passage. Eight miles above Srinagar are well marked incised meanders, with flat terraces in the cores.

In this sector of the river, boulders are often seen flanking the roads. They are mostly water rounded boulders, which formed the bed of the river in the past. At a few places the boulders are sharp and angular. They are found when the road cuts through screes and talus cones made up of frost shattered rocks, which roll down

from above, Conglomerate boulder beds formed in Miocene and Pliocene should not also be ruled out.

Beyond Rudra Prayag quartzites form stable and hard rocky walls of the gorge. Terrace development is very common. Three terrace levels are seen very often. They are sliced at times by deep gorges cut by tributaries through them.

Another very large terrace is found at Gauchar, which is so big that an air-strip has been constructed on it. There are a number of villages situated on this flat piece of land.

At Chamoli a road goes to Kunda ' Chatti on the Kedarnath route. A hill top is being cut into a flat piece of land to build the new district headquarters. A motor road bridge has been built over Alakananda.

The original Chatti is a labyrinth of huts on the bank of the river. As the first motor road arrived, it was about 100 metres above the river. The present town is situated here. And now the third town is being built on the flat hill top on the opposite bank. All this is possible because of the open aspect of the valley. Seven kilometres further up from Chamoli a road leads up the Birahi Ganga to Golna Tal, formed by the blocking of the river valley by a big landslide in 1890. It is now a lovely tourist spot.

The terraces end at Pipalkothi. Beyond occur soft schists and slates, which are very unstable. Here the previous pony track passes through Patal Ganga, a deep cut gorge in slates, where land-slides very often obliterate the route. To avoid this the new motor road zigzags down into the gorge at Belakuchi, crosses the river and runs along the stable gneissic rocks for two kilometres, recrosses the river again and zigzags up the gorge to Joshimath.

Deep in the gorge at Belakuchi, one can have a close view of the steep rock faces of truncated spurs, a creation of ancient glaciers, which came up to this



place. Water-falls thunder down over them as hanging valleys, as the one at Belakuchi. From Joshimath high up, this phenomena is not seen so clearly as the higher regions have gradual slopes. The ridge opposite Joshimath shows a clear cut synclinal structure, proving inversion of relief.

Below Joshimath the Dhauli Ganga joins Alakananda at Vishnu Prayag. Glacial topography is discernable clearly from this point onwards. The river is now busy in cutting a V inside the glacial U-form. The shoulders of U can be easily seen. At places, however, two or even three shoulders are noted. This proves the phenomena of multiple glaciation. The glaciers advanced and retreated during the cold and warm spells. When they advanced and retreated for the second time, the river had dug deeper. In fact it must have cut a V in the bottom of the U, which was reshaped into another U by the second advance. The rocks in this part of the valley are contorted gneisses, schists and quartzites. Being hard to erode, gneisses and quartzites have maintained these forms.

At Gobind Ghat Bhyundar Ganga meets Alakanada from the north. This is the "Valley of Flowers". Its glaciated scenery is no less enchanting than the yellow stone or Yosemite National Park. Bhyundar itself is a hanging valley and the water-fall has broken down into a number of steps. Other obsequent hanging valleys discharge into Bhyundar itself in silvery cascades. Upper Bhyundar drains the eastern slope of Nar Parvat and the western slopes of Gauri and Hathi Parvats. A beautiful tarn named Lokpal lies at a height of 4,800 metres between two spurs culminating in Sapt Shring and Bandarpata peaks, both above 5,000 metres high.

From Gobinda Ghat to Pandukeshwar and Vinayak Chatti the valley bottom is somewhat broad and strips of cultivable land are available, which give good crops

of potatoes. But the enclosing rock walls of quartzite are steep and look formidable. Rock debris shed from these form large talus cones. Detrital fans are formed where steeply descending mountain streams debouch into the main valley. Opposite Vinayak Chatti, the fans coalesce, and there is a small piece of triangular land, which is well cultivated. The common hill crops are potato, "Chua" millet with its red tuft, "Madua", maize and paddy.

While chirpine ( *Pinus longifolia* ) is very common from Rudra Prayag to Joshimath along the road level, higher up grow dark green deodars. There are oaks ( *Quercus incana* ) here and there. But beyond Pandukeshwar the pines disappear. There are more deodars and also various kinds of oaks. The Indian oak is very common. There are a good number of horse-chestnuts or "Pangar". Tree rhododendrons are also seen.

Beyond Vinayak Chatti up to Hanuman Chatti the oaks predominate. Tremendous cliffs of truncated spurs are seen at Lambagar. Just before Hanuman Chatti Khirao Ganga joins the Alakananda. From this point the source of Alakananda in the snouts of the Satopanth and Bhagirath Kharak glaciers is hardly 20 kilometres. Khirao Ganga rises from the snout of Panpatia glacier hardly ten kilometres away. The valleys above this junction of the rivers are choked with immense quantities of glacial debris resulting from pleistocene glaciation, and also present glacial and frost erosion.

Above Hanuman Chatti large amounts of glacial debris of the past are found clinging to the sides of the gorge at many places, and they increase as one goes up. Just near Hanuman Chatti there is a large deposit of glacial till, which has made road making rather hazardous as the unstable boulder beds slide down very easily. Further up, the road has been literally blasted from vertical cliffs of gneiss.

Two kilometres from Badrinath, the valley opens out into a circular undulating plain made up of glacial till.

Just below this point occurs a very important evidence of double glaciation. On the opposite side of the gorge is seen a bed made of outwash material wedged in between two beds of boulder clay. This conclusively proves a sequence of advance, retreat and a second advance of the ancient Alakananda glacier.

The bowl of Badrinath surrounded by steep rocky cliffs and filled up with boulder clay is an ancient gigantic amphitheatre or cirque. The glacial ice must have filled it up to some 400 metres depth up to the tops of the present cliffs. Later on this bowl must have been covered by forests of birch (Bhurja Patra), Juniper, and rhododendron. The occurrence of a hot spring called Tapta Kund decided the site of the temple of Badrinath. The rolling landscape and the forests were ideal for the congregation of pilgrims. The forests have disappeared since then, for supplying fuel. They should be replanted.

Tapta Kund spring gives out nearly boiling water. According to Dhir, R. D., the discharge is one gallon of water at 130° F per second.<sup>1,2</sup> Gansser says that the temperature varies from 121° to 118° F. In any case it provides an unlimited supply of hot water to the pilgrims for bathing and other purposes.

The town of Badrinath has grown up on the western bank between the river bank and the rock cliffs surrounding Narayan Parvat (6,500 metres), spreading down up to the junction with Rishi Ganga which descends from the dazzling silvery, and near perfect horned peak Neelakantha (7,200 metres) often called the Queen of Garhwal. The town is now and then damaged by avalanches falling down the cliffs of Narayan Parvat. Artificial attempts to check them have naturally proved futile. It is proposed to extend the town on the eastern bank.

The small valley of Rishi Ganga is a perfectly U-shaped valley with steep cliffs rising on both sides. Its bottom is choked with glacial debris and boulders 300 metres thick, all grassed and bedecked with brilliant alpine flowers.

The snow-melt waters of Neelakantha, presenting a back-drop and the flanking Narayan Parvat and Dhamling Dhar percolate through the loose material and ooze out as numerous sparkling springs all over the place. Rishi Ganga has cut a gorge in these old moraines at the southern edge. This seems to be common in this region. The southern slopes of E-W ranges get more rain, snow and sun than the northern. So erosion is more marked on the south facing slopes from where much debris continues to fall into the valley, pushing the streams to the south. The valley is hardly five kilometres long. About a kilometre away from Neelakantha there is a conspicuous N-S grassed ridge of moraines running across the valley from end to end. The river now cuts a gorge through it. It is obviously an old terminal moraine about a hundred or some more years old. This geomorphological feature is repeated at many other places in the Himalaya.

On the eastern side of Badrinath rise rock cliffs facing the western slopes of Nar Parvat (6,500 metres). From it descends the hanging glacier-Kuber, which is cut by many transverse crevasses, with longitudinal crevasses along its flanks. To its south is an ice fall broken into blocks of blue ice and discharging water-falls dropping over the cliffs. All around the Badrinath bowl the peaks are badly frost-shattered and look like great rock birds pointing their long beaks slantingly upwards. At times the rocks burst with tremendous noise like the booming of cannons, raising clouds of rock powder and discharging shattered rock debris, which roll down to talus cones below.

Wheat, barley and a kind of similar crop called "Phabar" is cultivated in patches here and there. Cultivation increases further towards Mana, the last village situated in another bowl. It is a large village on a stabilized talus slope above the river north and east of it, and is inhabited by semi-nomadic Marchyas. The houses are strong and well built, and made up of stone and straw. Some timber is also used. The Marchyas men folk are

essentially shephards and tend flocks of sheep, goats and black coloured cattle. There are a few Yaks and some cross-breeds. During summers the Marchya men flock go over to the high alps near the snow line with their flocks to feed on nutritious grass. As winter comes they move down to Joshimath and Chamoli. The sheep and goats are used for transporting wool and grain in small woollen bags.

The Marchyas have, however, cultivated the glacial terraces all round the Mana bowl, and the ripe, golden grain spreads all around the place. Potato is a very important crop. The women mainly are engaged in cultivation. In October they are seen with their children in the fields, harvesting the crop. They wear heavy black gowns, blouses and head cover, and decorate themselves with necklaces and trinkets of silver and multicoloured stone beads together with miniature swords and knives of silver. The people are very healthy and ruddy, but they are often very dirty.

An enterprising Marchya family has built a stone fenced field at Nagin below Vasudhara at a height of 4,200 metres, and a tin house for keeping flocks at night to save them from the attacks of marauding snow leopards and bears.

The Marchyas previously carried on trade with Tibetans across the Mana pass 40 kilometres to the north. The trade has now stopped. They now earn some money by supplying ponies for transport of goods of pilgrims, tourists and others. For the disposal of their dead bodies, they have strange customs. Often the body is carried up the Satopanth glacier to Satopanth Tal (lake), a glacial lake below Chowkhamba. Here the body is kept floating until it is pushed westwards, in the direction of the heavens ("Swarga") by the wind. It is then brought back to Keshav Prayag, the junction of Alakananda and Saraswati for cremation.

The Saraswati valley is a broad glaciated valley, choked with boulder beds and moraines. Numerous glaciers,

some of them conspicuously hanging, join it from the east. They come down from the slopes of giant peaks like Kamet. From the west another large system of glaciers form the river Arwa, which joins the Saraswati at the traingular land of Ghastoli at 4,500 metres. The Saraswati drops as a hanging valley into the Alakananda beyond Mana. Here the landscape consists of huge cubical boulders of quartzite which have dropped into the deep gorge. One of these called Bhimshila provides a natural bridge.

Higher up the Alakananda takes a turn at right angles towards the east. Here it acquires a true U-shape. All the geomorphological features noted in the Rishi Ganga valley are repeated have on a slightly enlarged scale. The river bed is filled up with deep beds of moraines, through which it cuts a gorge, leaving glacial terraces on both sides, but hugs the southern edge, due to much eroded debris being dropped from the quartzite cliffs to the north, parallel to the river. The northern flank of Narayan Parvat rises south of the river from which descend a number of corrie glaciers and have been stated in earlier chapters.

The cliffs decrease in height upwards. They represent the heights up to which the bigger glaciers in the ice age were filled with ice.

Aspect is a very important factor in microclimates in the glaciated areas. The duration of sunny hours at a spot depends upon the direction of the slope. The southern faces of ridges and cliffs get more sun. The northern slopes of Neelakantha and Balakun are cold and shady. Places where the high peaks cast their shadows are also cold. The sunny spots also support some vegetation, such as junipers and small bushes. Sweet, nutritious grasses and a variety of alpine vegetation including low bushes are also found in these places. "Guggul", which is burnt for producing scented smoke covers the upper sunny slopes, growing up to 5,600 metres. Guggul is found extensively on the slopes of Narayan and Neelakantha above the cliffs.

A particularly favourable spot is the triangular piece of flat ground lying at the base of Balakun, just above the junction of the twin glaciers. With the open valley of Alakananda to the east, it gets the sun very early. Except Balakun to its west, it is open on all sides. Being warm, sunny and perfectly flat it is a nice place for camping. Junipers growing around the place can provide fuel, while many springs oozing out of the glacial till may provide water. A small birch forest named Lakshmi Ban is found to the north of the snout.

- A series of talus cones spreading at the bottom edge of the cliffs are results of tremendous frost shattering in the high peaks and arete slopes. They provide material for the formation of lateral and other moraines. Here sometimes the movement of the glacier is too slow to shape them into lateral moraines, and they often obliterate themselves. Erosion being very intense on the sunny slopes, there is very well marked contrast between the northern and southern flanks of Bhagirath Kharak glacier. The lateral moraine at the foot of Balakun on the southern side disappears after going one kilometre.

In October the snow over the glaciers is minimum. The moraines covering the glaciers is subsiding all the time at various places producing a continuous rumbling noise. It is quite probable that for about a kilometre both the glaciers are in their last stages of disintegration. The thickness of glacial ice beneath the moraines may not be much. The glacial ice is further nearly at a standstill, and the glacial surface is full of pock marks caused by subsidences. Higher up on the Bhagirath Kharak glaciers there are multiple lateral moraines on the northern side, i.e., the southern flank of the Devdekhani group of peaks. This aspect is sunny, windy warm and the mountains are deeply eroded. The rocks consist of massive white granites speckled with black crystals of tourmaline and glistening flakes of mica. Heavy frost

erosion has reduced them to clusters of jagged snow covered peaks rising towards the sky in silvery spires.

Below the terrace appear multiple lateral moraine walls. Parallel depressions are seen running between the outer moraine and the rock cliffs. Here one often finds little streams running in braided courses or forming small lakes here and there. Furrows between two lateral moraines are often at a higher level. The outer depressions are even lower than the glacier. It is so because the glacier is riding at a higher level over the ground moraines deposited by the past giant glacier. This view is supported by Gansser and Heim who visited this area in 1935.<sup>13</sup>

The higher reaches of Narayan, Neelakantha, Balakun and Chaukhamba abound in sharply cut up aretes, ice steps, ice falls, yawning crevasses, gigantic walls of solid blue-green ice, overhangs and cornices. The slopes of Narayan around the peak are covered by lines of gendarmes. Prohibitive solid ice walls guard the spire of Neelakantha made up of white granite with tourmaline and mica. Avalanches thunder down the cliffs below it. Balakun rises like a tower of ice. It has been nicknamed avalanche peak very aptly. The higher slopes of Chaukhamba are also very unstable. They crack and thunder down as big avalanches at slight notice, perhaps a chill night, a bright sun or a fresh snow fall may press the trigger. Mountaineers have been swept to their death occasionally by them. They form coulours of cones of avalanche snow below the high slopes. It is a landscape of awesome beauty requiring much scientific study.

*Mandakini Valley*: The Mandakini rises from the Chorabari glacier descending from the slopes of Kedarnath peak (6,940 metres), while the Alakananda is a much bigger river collecting its waters from a large number of glaciers. The two rivers rise at a height of approximately 4,000 metres and flowing down less than 100 kilometres, join in a deep gorge at Rudra Prayag at a height of 1,000 metres.



From this point upwards along both the valleys one first meets a typical V-shaped stream eroded valley with interlocking spurs and wide river terraces left over by valley widening and deepening processes. The terraces are centres of human activity with villages, cultivated fields and roads built over them. They occur all along the valley upto Gupta Kashi.

An interesting point to note about the Mandakini is the break in its thalweg at Son Prayag where it first meets its major tributary Basuki Ganga. The waterfall is about 100 metres high. Possibly it is a rock step in the longitudinal profile of previously glaciated valley, occurring, as it should, at the junction of a tributary. The same may be said of the great break in the bed of Beas below Koti in Kulu valley.

#### Morphology of Kedaar-Badri Region

Kedarnath temple stands on a platform of loose and unconsolidated glacial till material. The platform is roughly five kilometres long and 2 to 3 kilometres broad. The Mandakini cuts a deep gorge into it being 200 metres deep on the average. The steep lower face of the deposit is seen from Rambara 5 kilometres below Kedarnath. The path zigzags over its face, climbs up to the top of the platform and then follows the river. The flanks of the Mandakini gorge reveal the nature of the loose material. Waterfalls and melting water from snow disappear into the ground above the valley and pour out through holes in the flanks of the valley. Some of these openings are dry and pour out water when there is large supply.

Dr. Fritz Muller in his account of research in the Everest region<sup>14</sup> also observed such large deposits of debris. He was impressed by "the new forms and dimensions" of the Himalayan scene, where everything is big as compared to Alps. He adds "One looked in vain for sound evidence of earlier glaciation. Only at Phaphlu did I see the first distinguishable moraine like

remnants, at Taksindhu the first erratic blocks were noted, and here on the slopes below was an extensive terrace system of uncertain origin. Descending in the Dudh Kosi valley which drains directly south from Mount Everest I was amazed by the numerous quaternary deposits none of which could be irrefutably identified as remnants of the main valley glaciation. Had they been washed away by large masses of water or 'did they lie buried beneath latter debris? The same question comes to the mind of the observer who looks up valley at the immense moraine on which the idyllic monastery of Thyangboche ( 4,000 metres ) stands."

Dr. Muller stayed on the Khumbu glacier below Everest for a full monsoon season and his rainfall records give a very interesting precipitation profile between the Everest region and the plains of Ganga. "This result shows very clearly the unexpected aridity of the Everest region." The total precipitation at 5,300 metres from 12th April to 26th November was only 39 c.m, compared to 199 to c.m at Chisapani and 225 c.m at Sirha on the Ganga plain.

Dr. Muller emphasized the need for a study of meteorological conditions to interpret glaciological and morphological findings. He explained the great accumulation of rock waste by the greater activity of erosive agents and the very slow action of the agents of transport due to extreme aridity. He says "Slow ice movement and little precipitation explain the vast quantities of debris in the lower ablation zone, as there is a correspondingly slow removal of the great masses of rock waste accruing from the very active weathering processes."

This logic if applied to the larger glaciers of the Pleistocene age may easily explain the existence of these huge deposits of rock waste, which in all probability are morainic deposits made by them.

The boulder strewn plain surrounding the Kadarnath

temple has also numerous springs oozing out of it, the water being supplied by the melting snows of the rampart of ice to the north.

The end moraine of the Chorabari glacier is a kilometre long and 150 metres high. A tongue of the glacier descends to its right side from which the Mandakini now issues. The moraine seems to lie detached from the present glacier which has contracted in recent times as many other glaciers have done in the Himalaya. The size of this moraine is also too large for the small glacier which produces it.

*Dhauli Ganga Valley*: This valley is much similar to the Mandakini valley, as it has also a large portion of its upper reaches cradled between the snowy "Himal" portion of Kamet group of peaks in the west and Nanda Devi Himal in the east. Though the Dhauli Ganga rises from near the Niti Pass on the Indo-Chinese border it receives much more water from East Kamet and Raikana glaciers, via the Raikana nullah. After a flow of about 100 kilometres, at first in a southerly and then in a westerly direction, through narrow gorges it joins the Alakananda near Vishnu Prayag below Joshimath.<sup>1</sup>

The Dhauli Ganga lies wholly north of the Great Himalayan Range which, in this region, contains the Kedar Nath Chaukhamba group of peaks and Trisul-Nanda Devi massif. This forms a mighty barrier against the spread of the monsoon. Naturally, the strength of the monsoon is very much weakened in the Dhauli Ganga Valley in comparison with the southern side of the Great Himalayan Range. It becomes feebler as it approaches the Kamet glacier in the Zaskat Mountain. Though precipitation varies within the valley itself, yet the average annual is only 50 centimetres.

The Dhauli Ganga Valley may be divided into three distinct units based on physiography and climate. The lower valley stretches from the confluence of the

Dhauli-Alaknanda ( Vishnu Prayag ) to the confluence of Dhauli-Rishi Ganga ( Reni ). The altitude of the valley bottom is 2,000 metres on the average. The length of the stretch is about 20 k.m. The gradient of the river is gentle and the valley is also wide.

Below Suraithota village the Dhauli is joined by Rishi Ganga or Reni, which pours out from inside the Nanda Devi "Sanctuary" through a tremendous gorge, which does not allow any one to enter the sacred Sanctuary.

The Sanctuary itself is a huge amphitheatre, perhaps the biggest and the most majestic in the world. It is surrounded by an array of gigantic pyramids of snow which include Nanda Devi, Duna Giri, Nanda Ghunti, Trisul and many other giant peaks. It is surrounded by "impenetrable" rock and snow ramparts, which did not allow man to enter the sanctuary for a long time. It was ultimately pierced by man from a high col above Latakharak.

From Reni to Maiari, a distance of about 40 kilometres the middle stretch of the valley. The altitude of the valley bottom is about 2,500 metres. Occasionally, the river has widened out to give rise to a broad plain in which the stream is braided. A lake, about a mile in length, has been formed at the confluence of the Dhauli and the Duna Giri nullah. The lake is believed by local people to have originated from a depression caused by a recent earthquake. A number of old pine trees are visible even now in the middle of the river bed or in the lake. The valley profile of this stretch can be conveniently broken up into three parts, namely, (a) the lowermost section with steep gradient corresponding to the present action of the river, (b) the middle section with gentle gradient corresponding to the formerly glaciated U-shaped valley, (c) the uppermost part, more or less flat, the former neve zone of the tributary glaciers.

The upper valley is from Malari onwards. The height of this valley bottom is 3,000 metres and above. Unlike

the first two stretches, the river here takes a meandering course and passes alternately through wide and narrow valley profiles. The valley from Malari onwards is wide and is particularly so near Reolcho, where the stream is braided. The river has widened out in three regions : (a) from Malari to Margaon, (b) from one mile below Reolcho to Gamsali, and (c) from Gotting to the confluence of the Raikana and the Dhauli.

Just south of the Tibetan border lies the northernmost pair of glaciers of the area, Raikana and Purbi Kamet. In front of their snouts lies the sacred place called "Vasudhara Tal." The Raikana River that originates here is an important tributary to the Dhauli Ganga, the sacred river of the Hindus. The nearest village is the Niti village ( 3,500 metres ), only about 16 kilometres from the present snout. According to the local villagers the journey to the sacred place was difficult even about five decades ago because of the presence of the glacier. But no such glacier has to be crossed today to reach the sacred place. Also it is stated that the snouts of the two glaciers were united even some 20 years ago. But at present the snouts are separated by, at least 1,000 metres. Heaps of fresh moraines on the outer shore of the terminal lake of the Purbi-Kamet glacier also indicate recent recession of the glacier.

Niti, the last village in this valley, is at a height of nearly 4,000 metres. The village site is above the river bed and well protected from avalanches by ranges and spurs on all sides. It is said by villagers that long ago the village site was near Temarsam, one mile downstream. But once devastating avalanches rolled down upon the village when there was a heavy loss of life and property. The settlement was then shifted to a safer position.

Selection of village sites is governed by topography. In the upper stretch from Malari onwards, villages are

not located at a very high level from the river bed and there are even some villages like Reolcho situated on the river bank. This is particularly true where the river bed is sufficiently wide and the situation safe.

In the middle and lower stretches from Malari down to Joshimath, village sites in general are in a higher position from the river bed. The reason behind the usual location at the junction of U-and V-shaped valley profiles is that from such a point they can look after agricultural fields in front and on pasture grounds in the rear.

Due to severe and extreme type of climate, a compact type of settlement has been developed throughout the valley irrespective of altitude, e.g. in Niti, Malari, Bampa. But where there is not enough space, an elongated compact type has become developed.

Though the compact type is the prevailing pattern, yet house-types of all villages are not similar. They depend upon the available building material and climate. In the lower stretch below Reni, where rainfall is heavy in comparison with other higher villages, the roof is more steeply inclined, but it gradually becomes less in higher regions. Walls are made of rock, cemented with mud. This is universal. But the roofing material varies locally. Up to Jummagwar, lying in the middle of the central stretch, roofs are made of tiles of slate. From Jummagwar to Gamsali roofs are of wooden tiles, made from local pines. The absence of slate and enough pine-wood brings about this modification. Above Gamsali, Niti is the last village. In this stretch, Niti is the only exception where rock slabs are used for roofing as pines are stunted and scarce on account of high altitude.

Two-storied buildings are common all over the valley. The ground floor is generally used for animals and as a godown. But in some cases, it is also occupied by the family. The first floor is exclusively used for dwelling. Floors are made of wooden planks. In the upper region,

a balcony is constructed within the house for a common passage. There are villages like Kosa where even four-storied buildings are found. Window, though small, are common.

The whole of the Dhaulī Ganga Valley is inhabited by several classes of people, namely, in the lower stretch up to Reni, by a mixed type of Garhwali, in the middle stretch up to Malari by Tolchas, and in the upper stretch from Malari onwards by Marchas.

There is a wide difference between the Marcha and the Tolcha so far as dress and culture is concerned. Though they live in the same valley, yet due to difference in origin and tradition and also environment, differences in customs and manners are very great.

The Tolcha people originally came from lower Garhwal where Rajput influence is strong. Rajput influence is also noted throughout the present area in dress, culture and also in festivals.

The Marcha were originally Tibetan. Even now, they are commonly called Bhots. But the scene is gradually getting changed. Local Garhwali dress is predominant among women in the lower valley. But Marcha women have a distinctive dress of their own. Marcha women wear a loose woollen skirt which is manufactured in their own village, and a woollen blouse, also manufactured locally. A cap with ornamental design in the forehead with a long strip of cloth attached to the back, is a common item of their dress. A roll of woollen cloth is often wrapped round the waist by Marcha women. Ornaments are used extensively by married women. Anyone can recognize a married woman whose husband is still living by means of her nose-ring.

But there is little diversity in the dresses of men in the Dhaulī Ganga Valley. Their costumes are similar to local Garhwali costume.

More or less, all the villages of the Dhaulī Ganga Valley are inhabited by Hindus. But the village of

Reolcho, at some distance above Malari, is a Tibetan Khampa village. Though they were originally Buddhist, their culture and festivals are now being influenced by the surrounding Hindus.

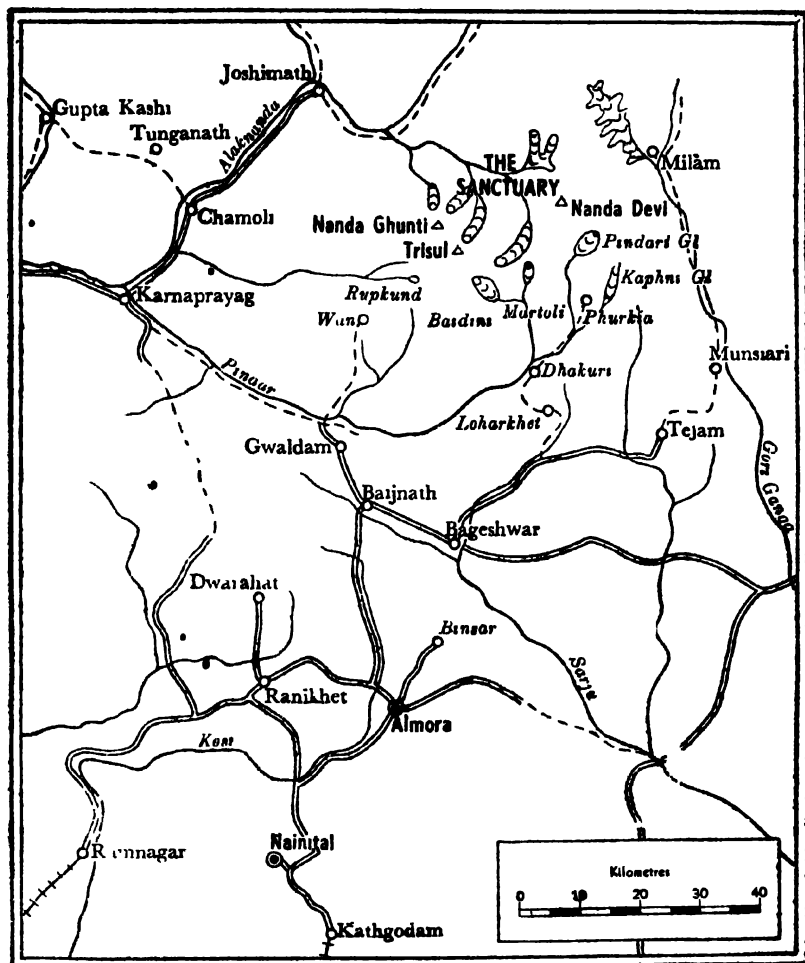
*Pindar Ganga* : This is the easternmost tributary of the Alakananda, which joins at Karna Prayag. The river rises from the snout of Pindari glacier which lies in the shadow of Nanda Devi, the towering snow spire ( 7,817 metres ) of Garhwal Himalaya and on the eastern edge of the stupendous outer face of the rock and ice wall of the "sanctuary" surrounding it. The glacier, though small in sizes is fed by tremendous slopes and flanks of peaks, which stand to its right as well as left.

Pindari glacier can be easily reached from Almora. It was a favourite place for British tourists, for whose convenience a series of staging Dak Bungalows had been erected roughly 15 to 10 kilometres apart starting from Almora they were Takula, Bangeshwar, Kapkot, Loharkhet, Dhakuri, Khati, Dwali and Phurkia. To-day, however, one can go by car or bus up to Barari, two kilometres beyond Kapkot on the new road to Tejam and then trek up the Sarju river to Loharkhat and beyond.

Coming to greater details of Pindari glacier, Coggin Brown and Cotter who visited the glacier in 1906 said that the glacier was fed by two ice flows, the larger originating from the neves on the slopes of Nanda Kot and the other descending in a cascade from between 6,322 metres peak locally called Bankhatia, or Chhanguch and an unnamed peak ( 6,591 metres ), which is some times wrongly identified with Nanda Devi by Bhotias of the vicinity, but is perhaps Nanda Khat. According to them the smaller cascade is of clear ice and is separated from the bigger ice flow coming down from the slopes of Nanda Kot by a medial moraines. About the western side, they added that the glacier was pressed close against a cliff wall, which produced an imperfectly developed right moraine, as compared to the left ( eastern ) moraine which was very



well developed. The bigger flow from Nanda Kot was covered by surface moraines which continued over the lower and last portion of the glacier.



Map 13

The snout of the glacier is at present 8 kilometres away from the last Dak Bungalow at Phurk'a (3,202 m.) situated below a steep cliff rising above the Pindar gorge, hidden amidst large boulders which must have resulted from rock

bursts higher up due to frost action. But the lodging of the boulders at Phurkia requires further explanation.

A study of the valley forms below Phurkia shows that the Pindar glacier and its tributary glacier Kafni, which joined it at Dwali ( Dak Bungalow below Phurkia at 2,563 metres ) proceeded further down up to about 4 kilometres above Khati, the last potato growing village on the route, i.e., down to about 2,500 metres. Below Khati the Sundardhunga stream meets Pindar. It rises from small glaciers descending from the southern face of the "rampart." Its valley from near Khati is normal V-shape with interlocking<sup>16</sup> spurs, proving that it was not glaciated up to this junction.

Thus the maximum extension of the glacier during the Pleistocene glacial periods is proved beyond doubt. But the retreat and advance of the glacier, which must have occurred 3 or 5 times, can be established only by further detailed work.

The factors controlling their retreats and advances, were (i) climatic changes, including cooling and precipitation and (ii) topographic changes connected with the uplift of Himalayan ranges.

Hanging valleys represented by waterfalls cascading over precipitous cliffs enclosing the Pindar river appear above Khati and continue beyond Phurkia. Some such cliffs are formed by truncated spurs. The cliff facing Dwali Dak Bungalow rises more than a 1,000 metres above it. Sprays of water descend over it into the valley below.

The ground moraine of the glacier which has now retreated seems to have been completely eroded up to very near Phurkia. Its remnants appear as small platforms standing above the valley, which gradually opens out above Phurkia. Huge talus slopes produced by materials tumbling down after rock bursts, frost erosion and avalanches are common features here. They rest upon the edges of the old ground moraine platforms. At Phurkia, it seems, that the flat ground moraine, which is being gradu-

ally eaten away by the enlarging gorge of Pindar river, has been removed very recently right upto the bungalow. The boulders which constitute old talus material, which fell and lay on the flat ground moraine of the past, now seem to be balanced precariously at the edge of the gorge. A tourist, when he first arrives at Phurkia, is disappointed at the closed view from here, obstructed further by the boulders. He thinks that the bungalow should have been situated further up on the flat moraine platforms, from where there would have been a very fine view.

Further up, the V-shaped gorge cut by Pindar into the thick mantle of the ground moraine of the past glacier becomes narrower and narrower, leaving broad belts of flat land between its edge and the towering ramparts of rocks. They are covered by lush green grass during summer<sup>17</sup>. They are the Bugiyals visited by shepherds of Garhwal and Kumaon. The nutritive value of the grass is well known in the region<sup>18</sup>. On the right side of Pindar are the Bugiyals of Kata, Chhier and Martoli, where a few temporary huts of stone, built by shepherds can be seen.

Further up, the moraine platform broadens out and is strewn by boulders. Such platforms of past moraine are also noticed at Kedarnath. A similar platform was noticed by Fritz Muller at Thyangboche.

At least two hanging glaciers are situated above Rata and Martoli. Below them is a sheer cliff, which extends nearly all round the "sanctuary". It has remained unclimbed in this portion up to this day by mountaineers trying to force a passage into the sanctuary to reach Nanda Devi.

Waterfalls cascading over the cliff thunder down during the day but become silent as night advances, as they freeze.

Talus cones and fans formed by streams lie in a line at the base of the cliff wall.

Coming nearer to the glacier one is confronted by a large old lateral moraine lying to the left (West) of the

glacier and the Pindar river. It is a gigantic wall of loose morainic material over-grown by grass and moulded by erosion to its present knife edge form. It is aptly called Chhuri Dhar locally.

The ice flows from the east joining the main glacier at Kupidhaura Bugiyal (3,816 metres) come down in two main branches. The eastern branch Tail Chhanguch glacier comes down from between Chhanguch and Nanda Bhanar. The southern branch Shel Chhanguch descends from the slopes between Nanda Bhanar and Lamchhir. Over them come down, at least five rows of lateral and medial moraines. They all join up at Kupidhaura and form the western moraine of the main glacier. The old Chhuri Dhar moraine was definitely formed from this source. Both Tail Chhanguch and Shel Chhanguch have now shrunk in size.

The main glacier from Traill's pass col to the snout is only 7 kilometres long and in this descends from 6,000 metres to 4,500 metres i.e., the slope on the average is 1:4. It is, however, convex, with 3 falls. the top being just below Traill's pass and the middle being below Chhanguch between two rock exposures, near a Nunatak like rock on the right.

The last drop is steepest just above the snout. It is more or less an ice fall.

In spite of such a steep fall, crevasses and pinnacles are not quite so prominent in the Pindar glacier as in other Garhwal glaciers.

This is, in all probability due to the very slow movement of ice. General Strachey who examined the glacier in May 1847 came to the following conclusion<sup>19</sup> :

**Mean Motion of Ice in 24 hours in Centimetres.**

	At lateral moraine.	On middle of Glacier.
Lower part of glacier	12.2	23.9
Upper part of glacier	13.5	25.4

This movement is very slow as compared to the motion given by Professor Tyndall of Mer-de-Glace in Switzerland<sup>20</sup>. The slow movement, however, is incompatible with the steep slope. The present decreasing supply of ice may explain it partly.

Currently there are evidences that the glacier is retreating slowly. Colonel J.W.A. Mitchell, who visited the glacier in 1894, said that the glacier had retreated about 100 metres since he visited it last in 1884. Coggin Brown and Cotter drew a sketch of the glacier in July, 1906. They set up specially marked stones at four points on both sides of the glacier.<sup>21</sup> Recent contraction of the glacier is evident from terminal moraines left below the present snout and ice cave.

Further, detailed observations are necessary to get the exact amount of contraction in the last 20 years. According to rough eye estimate and by comparing with Cotter's sketch it comes to about 50 metres. This estimate was also corroborated by Saradindu Bose and a party of geographers who visited the glacier in 1929. It seems that contraction has now slowed down as the present constricted form of the glacier leaves little scope for it.

However, according to their observations the Tail Chhanguch and Shel Chhanguch tributary glacier have shrunk very considerably than as shown in the top sheet based on surveys in 1936-38.

Coming further down from its glaciated gorge between Phurkia and Khati, the Pindar river flows nearly eastwards up to Gwaldam situated across a massive limestone ridge just south of the river. It is joined by snow-fed streams descending from snowy ramparts to the north, on which stands the silvery pyramid of Trisul, a conspicuous landmark in the ranges visible even from Nainital. On these slopes are a number of beautiful Bugiyals including Baidini Bugiyal, through which a difficult route ascends to the mysterious Rupkund tarn, where skeletons, skulls and

many other remains of groups of people have been found, who perished here by being buried in avalanches.

The Bugiyals are visited by semi-nomadic shepherds called Anwals. Unlike other valleys the Anwals tend sheep, goats etc. belonging to other people. They charge for their work commodities such as wheat, ghee, salt etc. The arrangement is made by a chief Anwal who stays in large villages. This custom is gradually changing, and at present bigger zamindars keep paid Anwals. The Anwals live in the high pastures during summer, where their meadows are marked by streams etc. They possess sheep-dogs who protect the animals from attacks of bears and leopards. They are not responsible for the death of sheep in their charge, but they must return some part of the body of the killed animal, say a hoof, to the owner.

In its last stages the Pindar runs in a V-shaped valley to the north-west where river terraces are well developed. This part of the valley has many good villages and cultivated fields. Forests are being developed. Much *Pinus longifolia* has been planted and timber is being extracted.

The combined waters of Alakananda. Dhauli Ganga, Pindar and Mandakini finally join the Bhagirathi at Dev Prayag to form the sacred Ganga, which emerges from its mountain fastness at Rishikesh and flows down to Hardwar and on to the plain of India, till it empties its waters in the Bay of Bengal near Sagar Island, where the legendary Bhagirathi brought the Ganga from Gaumukh to pour upon the ashes of the thousand sons of king Sagar who were burnt by the wrath of Kapil Muni, to send them back to Swarga.

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## Sikkim and Darjeeling Himalaya

Sikkim, Himalaya and the adjoining Darjeeling Hills to the south constitute a distinct physiographic unit of the Himalayan arc as it is bound by rather uncommon water-parting ranges running north and south, that is transverse to the grain of the Himalayan ranges. The ranges are the mighty Singalila to the west and Dongkya to the east. In between them lies the valley of Tista.

The region lies between  $26^{\circ}$ - $45'$  north latitude to  $28^{\circ}$ - $10'$  north and  $88^{\circ}$  east longitude to  $88^{\circ}$ - $50'$ . The area of the region approximately is 4,000 square kilometres.

The central Himalayan axis may be supposed to pass east-west through Kanchanjungha, the third highest peak of the world, towards Chomolhari on the Bhutan border, dominating the Chumbi valley.

As compared to western Himalaya, geological investigation has been slower in the east due to heavier rains, when movement becomes difficult. Also consequently there is greater vegetational cover, including Rhododendron bush growth in higher areas which cover and blanket geological formations.

Geological investigations started in this area when Hooker wrote about it in the "Himalayan Journal" in 1854. He first traced the regional domel character of the gneisses and observed crinoidal limestones at Tso Lhamo, the famous Lake near the Tibetan watershed. Others who followed were Mallet, Bose, Hayden, Dyrenfurth, Auden, Heim, Gansser and many others.

The sub-Himalaya in Sikkim entirely consists of Siwalik and younger deposits. "Extending from Nepal, the Siwalik hills can be followed as far as 20 kilometres east of



the Tista river, where they are missing for somewhat about 10 kilometres and then come out again and disappear below the advanced spur of the lower Himalaya near Jaldhaka river.

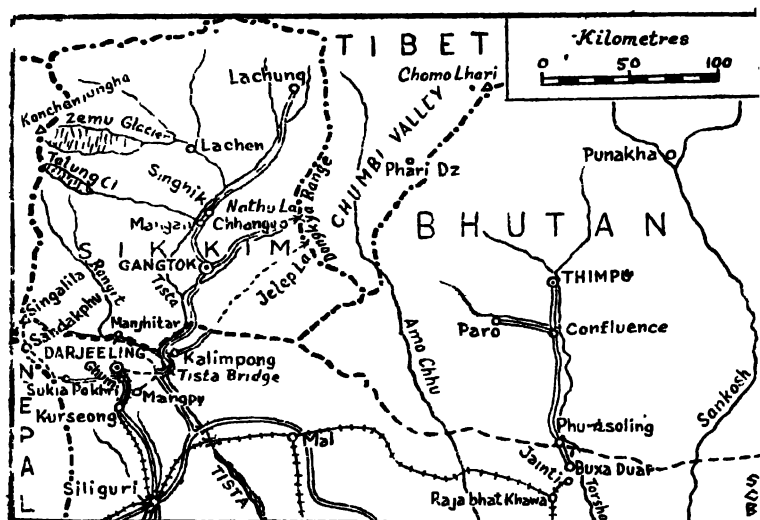
“Good Siwaliks exposures are not with along the Tista river. The deepest outcrops forming the southern margin of the Siwalik Hills consisting of bluish grey nodular marls and clays with micaceous fine grained sandstones. Upwards they grade into 1,700 metres of grey sandstones dipping northwards at about  $45^{\circ}$ . In the last 300 metres we find sandstones with conglomeratic layers, where quartzite pebbles predominate. Northwards, along a tectonic contact, following a steep layer of tectonized sandstones with dark shales and coal seams. Still further north we meet outcrops of Gondwana type coal bearing sandstones with a basic still, but the main boundary fault is not exposed. This over 2,000 metres elastic section forms the north flank of a normal anticline the core of which is just exposed at its southernmost outcrop. The exposed section could be placed into the Middle and Upper Siwaliks. Further in the Siwalik region are found sub-recent and recent terraces, which clearly display the last tectonic displacements.” Gansser observed strong erosion and warping of these young deposits along the Jal Dhaka river, east of Tista, where a Siwalik outcrop is rather suddenly replaced by recent river deposits. He noted a pronounced warping of the three principal terraces forming a hill paralleling the mountain front, like an incipient recent anticlinal structure.

River terraces occur also very often along the Tista Valley while the terrace levels are accident, the river cuts deeper into them as it advances southwards.

“The regional geological outline of Sikkim Lower Himalaya is rather simple. There is a domed cross feature, with a core of uniform Daline slates and schists overlain by gradually increasing metamorphic horizons, ending in widespread gneiss sheets which support the

highest mountains to the west and north or the southern front. A narrow strip of Gondwana rocks is wedged between the Siwaliks and the older Dalings.

"The Damudas are characteristic coal-bearing detrital rocks, their fossil flora ( *Glossopteris* ) indicating a Lower Gondwana age. Up to 12 coal seams are met. Generally the coal is highly sheared and frequently altered to anthracite. Some carbonaceous shales have become graphitic and the sandstone often quartzitic. The best coal seams measure about 3 metres at Tindharia.



Map 14

Dalings consist of greenish greasy feeling slates and quartzitic schists. The former predominate and are responsible for landslides, specially in the Tista valley. There is an upward progressively increasing metamorphism of the Dalings.

Darjeeling gneisses consist of garnetiferous gneisses, sillimanite biotite gneisses, pegmatites and aplites.

Kanchanjunga consists entirely of crystalline rocks in which augen gneisses of granitic origin dominate.

In the head waters of the Lachen River which cuts

through the main range lies the beautiful Tsolhamoe (Lake Goddess). Here fossiliferous limestones<sup>o</sup> were noted by Hooker. Auden further investigated the area and noted that the gneisses were overlain by fine arenaceous grey limestones, not unlike the main Everest limestone.

Between the higher and more massive Singalila Range culminating in Kanchanjunga in the north and forming the Sandakphu ridge in Darjeeling and the Dongkya range between Sikkim and Chumbi Valley lies the Tista valley. It is fed by many large glaciers including Zemu from Kanchanjunga. Its main tributary Rangit also is fed by many glaciers and its deep east-west portion separates Sikkim from Darjeeling.

Darjeeling Hills consist roughly of an H, whose eastern north-south ridge forms the Darjeeling spur in the north and the Dow Hill spur in the south starting from Tiger Hill, the highest peak in Darjeeling. The Ghoom ridge, a western spur of Tiger Hill, forms the middle of the H and joins Singalila range below Tonglu near Sukia Pokhri.

A number of small rain-fed streams run south of Ghoom ridge to the plains. They are the Mahanadi, later called Mahananda, the Belason and the Meechi on the border.

There are many economic resources in this region. The lower valleys of Sikkim and Darjeeling are well known for their oranges. Higher up in Sikkim apple are grown. Potatoes are extensively grown and in winter seed potatoes are sent to the plains. Darjeeling hills also supply vegetables to the Calcutta market.

But the most important agricultural product of Darjeeling is tea. The greatest extension of the gardens is at about 1,250 metres level. Ambhutia and Singell Tea estates near Kurseong are at this level. They are large producers.

Below this level tea is inferior, but above it up to 2,000 metres and more the coveted Darjeeling tea is grown, known all over the world for its aroma.

At Mongpu is situated the Government Chinchona Plantation. It also produces Tung oil and ipecac.

Forests give much good timber. Afforestation of pines is done and there is a forestry school in Kurseong.

Darjeeling is one of the oldest hill stations established by the British. It is connected to the plains by a good road and a railway. There is a road to Kalimpong. Jeepable roads have been constructed in many places in Darjeeling Hills, such as the one to Mangpu and other to Darjeeling from Tista bridge. Another road ascends to very near Sandakphu to nearly 4,000 metres, while another descends to Rangit valley and joins the Tista bridge.

A fine broad road has been built up to Gangtok from where a road reaches Nathu La to a bit less than 5,000 metres. Another beautiful road has been built to North Sikkim on which Buses ply up to Mangan and Singhik. There are two old ropeways and new ones have been built.

Darjeeling hills are well populated. Here Kurseong and Kalimpong are two main hill stations. More development is taking place day by day.

Darjeeling is a great tourist centre from where one views the Kanchanjunga group of peaks which include Pandim, Narsim, Jano and Kabru. From Tiger Hill one can also have a glimpse of the Everest.

The view of sunrise from the Cooch Behar plains, and its pink rays falling on the snowy Kanchanjunga group peaks, as seen from the Tiger Hill, is a unique sight in the world, because of the great height of Kanchanjunga which catches the pink rays, much before the rise of the sun above the horizon, due to the curvature of the earth. The phenomena is called "pinking."

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